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THE FRANKLIN INSTITUTE.

In Memoriam.

COLEMAN SELLERS.

January 28, 1827—December 28, 1907.

*The loss of this valuable citizen and great director of industry will be felt throughout the world of enterprise and education, but nowhere more acutely than by the Franklin Institute, of which he was for five years the President, and for twenty-three years Professor of Mechanics.

A grandson of Nathan Sellers, surveyor, conveyancer, and Ensign in a company of Pennsylvania Associators which took the field with General Washington in the Long Island campaign of 1776, a skilled mechanic of such ability as to induce Congress

*Many of the data in this short memorial sketch have been based on the article of the late Dr. Henry Morton in Cassier's Magazine for August, 1903.

TACONY BR.

on the petition of the American paper manufacturers, to re-call him from military service to inaugurate the manufacture of paper for cartridges; son of Coleman Sellers, inventor and mechanic: grandson on his maternal side of Charles Wilson Peale, the gifted artist, soldier, naturalist, and statesman: Dr. Coleman Sellers had through heredity the genius of observation, comprehension, and achievement.

He was born in Philadelphia January 28, 1827, but had the misfortune to lose his father by death when he was but seven years old. After a rudimentary education in private schools, supplemented by the instruction of his mother in a system of manual training of her own devising, he entered the academy of Anthony Bolmar, of West Chester, Penna., in 1838, at the age of eleven. At the very outset his imagination was stimulated by the simple experiments in natural philosophy which his instructors employed, and at once he began a career of invention, which never actually terminated till his death. Six years were passed at the West Chester school, which he left in 1844 at the age of seventeen.

The career selected for Dr. Sellers by his mother was that of a farmer, and two years were spent on a farm. But this occupation did not fulfil his yearning to use the faculties which he felt within him, though it served to draw from his practical mind an early invention which, like many of his subsequent inventions, anticipated the essential features of a construction destined to universal use, viz., the metal-pronged hay-rake on wheels. At nineteen he entered the service of his older brothers, Charles and George Escol Sellers, in the Globe rolling mill at Cincinnati, Ohio. Here he remained three years, part of the time as Superintendent of the works; after which he became foreman of Niles & Company, locomotive builders.

His familiarity with all forms of rolled and drawn metal at this time, and especially his practice in producing iron wire for a telegraph constructor, induced him to take up and repeat some of the experiments of Michael Faraday. He also devoted part of his leisure to the making of collections in natural history, and to the study of Swedenborg's philosophy. In 1851, he married Miss Cornelia Wells, of Cincinnati, and in 1856 returned to Philadelphia and became chief engineer of the machine tool works of his cousins, William Sellers & Co. This position he retained for thirty

years, during which time he made many improvements in the tools and processes of this leading American establishment.

Every change of occupation was marked by his development of a new and correlated study. Just as farming stimulated him to invent the metal rake, and drawing iron wire led him to the study of some of the phenomena of electricity which the wire was intended to convey, so his management of the draughting room of William Sellers & Co. suggested to him, in 1858, the use of photography as an aid to the methods then in use for illustrations of machinery. He took the art up and very soon perfected himself in applying it. This again led him to devise a rough prototype of the Kinemetographs, now in use for exhibiting moving pictures.

Similarly having occasion to use the microscope, which had not previously engaged his attention, he rapidly attained the skill necessary to prepare and mount thin sections of solid objects, a process which had been applied to the study of mineralogy by Vogelsang, and later Zirkel, about 1868 to 1870.

But he did not stop here. Being now completely established in his triple character of practical manufacturer, scientific experimenter, and teacher, he arranged a projecting lantern to show these slides on the screen by the aid of the oxy-hydrogen light; and to obtain this light he manufactured the oxygen, as this gas was not then a purchasable commodity.

Those who attended the lectures on Mechanics which Dr. Sellers gave during several seasons at the Franklin Institute, will recall his happy faculty of explaining a difficult problem or an intricate piece of mechanism in simple words so that his hearers could not fail to understand the subject. A number of these lectures were stenographically reported, and are preserved in the pages of the *Journal* of the Institute. Dr. Sellers' contributions to the *Journal* cover a wide range of topics, which if collected together, would make a good-sized volume. His latest articles refer to the preliminary meetings held in New York and London to consider the practicability of generating electrical power at Niagara Falls, the conferences of the International Niagara Commission, and also describe some of the final plans adopted. Dr. Sellers was chairman of the Board of Engineers appointed to carry out the plans, many of which were of his own devising. When the tunnel was nearly completed and the time for the instal-

lation of the machinery was near at hand, the object of the Board of Engineers had been accomplished, and it was dissolved. Dr. Morton said, in the article already mentioned: "It then became preëminently the task of the mechanical engineer to consider and apply the devices best adapted to so control and utilize the forces as to secure the best engineering and commercial results. Dr. Sellers was accordingly made chief engineer of the Cataract Construction Company, and while its separate organization was called for he served also as president of the Niagara Falls Power Company. It thus devolved upon him to suggest and devise the various details of the installation at a time when its principal features were essentially experimental, and it is needless to say how successful has been the outcome of the conservative course pursued by him throughout his active connection with this work." It is hard to realize in these days of electrical development, that when the Niagara Falls project was conceived little was known definitely about many questions which have since been clearly determined, and are now almost matters of common knowledge. Prior to 1893 the largest generators in the world were not over 2000 H.P. in output, and though in Switzerland some generators had been made operated by vertical shafts directly from waterwheels, there were none approximating in size the units selected for Niagara, nor were any driven by vertical shafts of the length and speed required in the new installation. Perhaps the most important work done for the Niagara Falls Power Company by Dr. Sellers was in shaping the policy of the Company in regard to certain of these important questions which arose, especially during the sittings of the International Commission in London, and during the constructive period, from 1889 to 1893. On many of these questions there was the greatest diversity of opinion and conviction among the technical advisers of the Company; and wise judgment, great tact, and courage were required to select and determine the best course to pursue, and to harmonize the various conflicting views. One of the first of these grave questions arose in London, when Sir William Thompson (Lord Kelvin) offered a resolution committing the Company definitively to the use of the direct current. This Dr. Sellers opposed successfully on the ground that the possibilities of the alternating current at that time were not sufficiently understood to justify such action. When, at a somewhat later period, the alternating

current had been finally decided on, the number of phases and voltage had to be settled and the relative advantages considered in the light of the limited knowledge of that time. It required almost a prophetic insight to forecast the probable course of electric development, and though not a professional electrician, Dr. Sellers was able to grasp the most technical questions by means of the thorough knowledge of principles which he acquired as a young man through experimental work done during his limited leisure time.

While acting as Chief Engineer of the machine tool works of William Sellers & Co., Dr. Sellers invented many new and ingenious devices that contributed largely to the success of that firm and gave to it the international reputation which it still retains. Among the best known early inventions is the double-cone coupling for shafts, which was probably the first successful substitute for the flange, or plate coupling, previously used. This invention made a radical change in the manufacture of shafting, cheapening the cost of production, and greatly facilitating installation and repair.

Among the twenty or more patents which were taken out by Dr. Sellers in the interest of William Sellers & Co., either alone or with others, while he was connected with the house, we find a variety of subjects which gives indication of the versatility of his mind. Besides the shaft-coupling already mentioned, we note improvements in Injectors for feeding boilers; a machine for rifling gun barrels; an automatic stop for bolt cutters; coupled with an improved oiling device by which the lubricant was delivered through the center of the die box directly on the work; improvements in punching and shearing machines; an original type of turn-table for pivot bridges; automatic valve gear for steam hammers; numerous improvements in hydraulic presses, of which probably the most notable was an ingenious method of lining cylinders with copper, so as to prevent the passage of the fluid into the casting of which the cylinder is composed; automatic relief valve for hydraulic accumulators; a slide valve for the steam riveter, permitting the steam used in making a stroke to act expansively and withdraw the ram for the next stroke; improvements in presses for putting railway wheels on their axles, which is substantially the type of machine now universally used; an ingenious friction device for machine tool feed motions, by which

an infinite number of gradations in amount of feed can be obtained by the simple movement of a lever. Another feed motion patent covers an ingenious application of the epicylic train or "sun and planet motion," for transmitting either a slow feed movement or a rapid traverse for adjustment through the same mechanism. He also invented an interesting device for transmitting motion but preventing reaction.

All of the machine tools designed by Dr. Sellers were characterized by simplicity of design and beauty of form; they possess a distinct individuality that enables an expert to recognize them at a glance without referring to the name-plate on the machine.

As an illustration of Dr. Seller's keenness of perception and fertility of resources, an incident may be briefly mentioned here, chiefly because it has never been elsewhere recorded. About the year 1868, an inventor brought to the Franklin Institute for examination a lock which he confidently declared to be "unpickable." There was no key-hole visible, but on very close inspection it was apparent that a small square hole had been cut out of the steel plate forming the outside cover of the lock and a small plate of steel had been accurately fitted therein and polished to match the rest of the surface. Various unsuccessful attempts had been made by the writer and others to draw out this small square mortiсed plate, when Dr. Sellers happened to come into the office, and after examining the lock for a minute, he procured a small piece of beeswax and a little piece of thin spring steel; bending this into the form of a bow he attached the beeswax in the middle of the spring and pressed it firmly against the inserted square plate; on removing his thumb the steel bow sprang up bringing the square plate with it and revealing a key hole beneath. Dr. Sellers then made a false key with two pieces of wire and in a few minutes he successfully picked the lock, greatly to the discomfiture of the inventor and surprise of the other spectators. The inventor stated that he used a horse-shoe magnet to withdraw the square plate covering the key hole, and had never thought of Dr. Sellers' simple scheme.

Dr. Sellers was elected to membership in the Franklin Institute in 1858, two years after his return to Philadelphia, and from the first, took an active and prominent part in its affairs. He was elected to the Board of Managers of the Institute in 1862, and served continuously on the Board from that time until re-

cently, when physical infirmity caused him to withdraw. He became President of the Institute in 1870, and served in that office until 1874. He was also for many years a member of the Committee on Publications; and of the Committee on Science and the Arts. In 1899, as a recognition of his long and valued services in furthering the work of the Institute, he was made an Honorary Member on the occasion of the celebration of the 75th anniversary of its foundation, when he delivered an address on "The Progress of the Mechanical Arts in three-quarters of a Century."

His contributions to the *Journal* of the Institute during the long period of his active participation in its work were very numerous —no less than twenty-nine titles appearing to his credit in the several indexes, covering a wide range of subjects and constituting an interesting tribute to the versatility of the author's knowledge.

Possessed of much sympathy and social instinct, and a large fund of quiet humor, it was impossible that Dr. Sellers' aptitude for experimentation, and his ingenuity in the production of new phenomena should not have led him to the application of his talent for the amusement and instruction of others. So from his early years he was expert in the magician's art and in thaumaturgy. These talents were like all else of his, used for the highest purposes. They beguiled many a sufferer in a military hospital during the civil war, and later they were turned to the good account of the entire community when he served as a member of the Seybert Commission to investigate the phenomena of Spiritualism.

He could readily reproduce, under similar conditions, all the mysterious happenings which were shown him, and thus afforded the most valuable object lessons of the futility of basing conceptions of the Universe and life upon the interpretations a casual visitor might make of the sensations of sight, sound, touch, taste, and odor which he might experience.

In 1884 he visited Europe for the first time, representing this Institute as its Professor of Mechanics and delegate to the tercentennary of the foundation of the University of Edinburg. This professorship he filled honorably for twenty-three years, until his decease.

In 1886, he again went to Europe, and on his return was compelled by ill health to resign his position as Engineer of Wm. Sel-

lers & Co., Inc., and other permanent duties, but continued his activities as a consulting engineer. As soon as this became known, the Stevens Institute of Technology established a chair of Engineering Practice, and called Dr. Sellers to fill it as a non-resident member of the faculty. The chair was intended originally as a paene-graduate course for the Senior class, but his lectures were attended by the members of the Faculty also, who received from them, as Dr. Morton, the President of the Stevens Institute, says, many hints which aided them in their several courses of instruction. In 1887, Dr. Sellers received from the Stevens Institute the honorary degree of Doctor of Engineering, and in 1899, that of Doctor of Science from the University of Pennsylvania.

But the crowning glory of his professional career was his wise direction of the Niagara Falls Power Company. This has been before alluded to, and is familiar to all scientific men throughout the world.

Any one of the half dozen connections which Dr. Sellers had with this great enterprise would have sufficed to make the reputation of an engineer, and would be cherished as an honor by his descendants.

Beginning with the request of Mr. E. D. Adams, of New York, in 1889, that he report on the practicability of generating electricity for the transmission of power from Niagara Falls, through his chairmanship of the Cataract Construction Company; his participation in 1890 in the organization of the International Niagara Commission at London (thus meeting as colleagues Lord Kelvin, Lt. Col. Turrettini, Prof. Mascart, and Prof. W. C. Unwin); his appointment as Chief Engineer of the Construction Company; and terminating with his great success in planting the enterprise on a stable and profitable foundation; this part of his life is unsurpassable for successful achievement.

As a man, his history is not less notable. Gentle, unassuming, kind, and considerate, his social nature, even to those not of his intimate acquaintance, was most attractive. As a citizen he was not afraid to denounce wrong and to uphold right, even in the face of popular clamor.

Whatever views Dr. Sellers held on any subject one was sure, not only that they were the result of careful thought, but that they were the honest outcome of that thought. Of him we can say:

"Semper honos nomenque tuum laudesque manebunt."

(*Annual Meeting, held Wednesday, January 15th, 1908*)

"Electro-Magnetic" Automatic Telegraphy.

(The "Telepost.")

By Patrick B. Delany.

A little more than eleven years ago it was my privilege to bring before the Institute certain improvements in Automatic or machine telegraphy. It is my purpose this evening to show and explain a new method which is the logical outcome of results obtained with that system, and due to experimentation carried on continuously since that time.

Before taking up the main subject, however, I wish to bring to your attention certain developments in what might be called "Electro-Magnetic" Automatic Telegraphy, to distinguish it from the much more rapid "Electro-Chemical" system, in which no electro-magnets are used.

As you all know about the ordinary Morse system, comprising the relay, sounder and key, it will be easy to understand the modifications by which it is proposed to improve Morse working, to the extent of quadrupling its present message capacity, whether the wire be used for simplex, duplex or quadruplex transmission.

In these days it is hardly worth while, however, to include the Morse Quadruplex in any practical estimate, as its day is about done, owing to increasing underground construction and inductive interferences from power wires. Wherever operable, however, the ratio of gain will hold.

The President of the Western Union Telegraph Company stated publicly last April that 99 per cent. of the messages handled in this country were still transmitted by the old-fashioned Morse key, at a speed averaging seventeen messages an hour, and stated also that this was considerably less than the speed of several years ago. Allowing thirty words for each message, including ad-

dress, date and signature this shows an average of nine words per minute per circuit. Thus it seems that while the transfer of energy over a wire in another department of electricity has been increased from a few hundred volts to seventy-five thousand within the last twenty years, the transfer of *words* has fallen off during the same period, and is now about one-fortieth of what a wire is able to convey.

Up to a few years ago there was strong opposition on the part of telegraph companies to the preparation of messages on tapes

Fig. 3. Keyboard.

preliminary to their transmission, but it is now conceded that in no other way can the speed of a circuit be appreciably increased, and the perforated tape is coming into use for even unimportant advances in telegraphy.

In the Electro-Magnetic Automatic System which I am about to show you the message is composed on a tape precisely as for the Electro-Chemical Automatic, which will be shown later. The Perforator (Fig. 1), (cut omitted), may be operated by the ordinary Morse key, the Auto-Dot Key (Fig. 2), (cut omitted), or by the Keyboard Transmitter (Fig. 3.) These transmitters may be

located in branch offices of a city, or at way stations, so that messages may be perforated from any distance at a central office ready for transmission at a high rate of speed over the trunk lines.

Fig. 4 is a diagram of the perforator connections. When the Morse key K is pressed down the circuit of battery B is completed through magnet M^1, contact C^1, rocking beam D, back to the battery, energizing magnet M, and attracting its lever L, which forces the punch P^1 through the tape Q. Just as the punch enters the tape the pin on the lever L pulls the tapering end of rocking beam D past its biasing spring X, on the end of which is a small roller, thereby breaking the circuit of Magnet M at C. This allows lever L to fly back to its stop V, after having made a hole in the lower edge of the tape. The rocking beam D, having

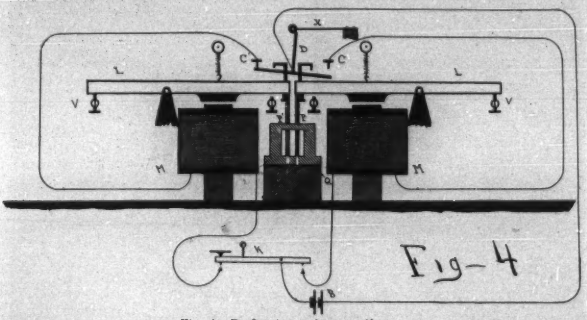


Fig. 4. Perforator and connections.

been moved to the left, the circuit of M is now closed at contact C, so that when the Morse key K reaches its back stop, magnet M is energized, lever L attracted, and punch P is forced through the tape, making a hole in the upper side. The tape is constantly running, but the action of the punchers is so quick, its movement is not perceptively checked. Thus, the perforating operator works his key in the regular way, the dots showing a slight angle on the tape, the dashes and angles corresponding to the time the key is held down.

Fig. 5 is a diagram of the Keyboard connections.

As the key K is pushed down and locked at L, spring S presses on sliding bar B, clamping it between revolving

rollers R and R^1. Contact finger F is drawn over the row of contact segments, which in this case represents a period,—two dots, two dashes, two dots. As the finger F passes over the segments the circuit of the transmitter relay T is made and broken through battery A and the characters formed. The armature lever H of relay T is connected to the line W. Its front stop is connected to the main battery A. At the completion of the movement forward of bar B, the latch spring L is pushed back and the key K released. As K rises it pulls bar B up with it by loop V,

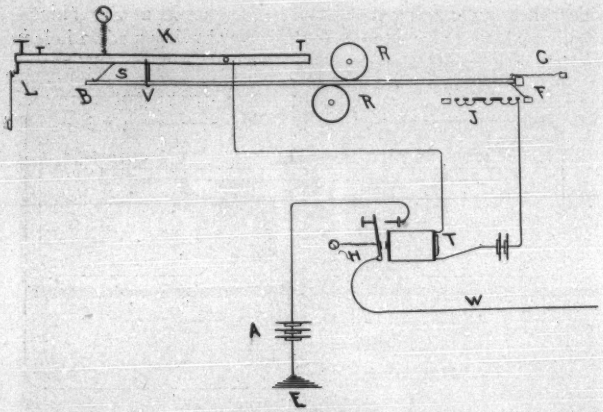


Fig. 5. Keyboard connections.

releasing it from the grip of rollers R R^1, when it is pulled back to the starting point by spring C. This backward movement is so quick the transmitter T is not actuated even with the lowest adjustment of the armature spring. In this way all mechanical or electrical contrivances for taking the contact maker F out of touch with the character segments on its return are unnecessary.

Four operators may be employed in perforating tapes by Morse key at the rate of twenty-five words per minute each, and the product of their united work sent through the Mechanical transmitter and reproduced on a perforated tape at the distant station. The tape is then distributed among four local circuits where a perfect reproduction of the original characters are ticked

off on the sounder and copied on the typewriting machine by the operator, just as if the characters were coming over the wire from the operator's key direct. Fig. 6 shows the transmitter in operation and Fig. 7 the reproducer at the receiving station (cut omitted). As a matter of fact, the original manipulation of an operator in preparing the message is greatly improved by the perforating process, since all impulses, whether regularly or imperfectly made by the operator's key, make the same sized hole in the tape. The impulses over the line must threfore be all uni-

No. 6. Transmitter in operation.

form. Of course, the variations in length of dashes or spaces will be faithfully duplicated on the receiving tape, but the evenness of impulses passing over the line from the uniform perforations greatly improves the general quality of the work. Obviously, the original preparation of the message and the transcription by sound may be carried on at any rate that the operator is capable of perforating or reading by sound. For instance, a Keyboard Morse transmitter can be used for perforating at fifty words per minute, there being no interruptions incidental to a line, and no

operator at the distant end to limit manipulation by the perforating operator. Similarly, the operator reading by sound from the reproduced tape at the receiving station may regulate the speed of his tape to any rate that he is capable of reading and working his typewriter, and may confirm any doubtful word by looking at the perforation. Of course, transcription may be done by reading from the tape direct by those not proficient in reading by sound.

An inexperienced operator at some way station may perforate ten words per minute, the message goes over the line at 100 words per minute, and is transcribed by sound, locally, at the receiving station at twenty-five words per minute. Ordinarily, if this message was sent directly over the line the entire use of the wire would be monopolized by the slow operator.

For through business, New York to San Francisco, for instance, a tape can be reproduced in Buffalo and used for transmission into a Chicago circuit, where another reproduction can be used for transmission to Denver, then again reproduced at Salt Lake, and finally at San Francisco, at 100 words per minute, as against an average of about twelve words by the present Morse method, using five or six automatic repeaters. Instead of perforating tapes, repetition may be effected by the movement of the perforating lever, or perforation and repeating may be done simultaneously at any station.

Duplexed, this system would yield 200 words per minute in perfect Morse, and without the slightest deviation from the regular Morse method, the sender working his key, and the receiver copying by sound, while the message capacity of the duplexed wire is increased from about forty words per minute to 200.

A most important application of this system will be for the distribution of press news. Drop copies can be made at 100 words per minute at thirty to forty way offices, either perforated on a tape for operation of a local sounder at any speed desired, or recorded in plain dots and dashes for deliverate transcription by those who cannot read by sound. A linotype operator knowing the Morse code will be able to compose directly from the tape. The reproduced perforated tapes may be used for re-transmission over other circuits, so that a news dispatch perforated in New York may be distributed all over the country, and news-

papers now too poor to buy press matter may be supplied at a nominal charge.

Coming now to the rapid automatic system which records one thousand words per minute, it may be said that the system originally brought before the Institute had as its main feature a method for recording signals in a special manner, with the view of overcoming the effects of static discharge.

A few words in an elementary way explanatory of this static discharge may be helpful to a better understanding of the means through which it is sought to surmount this most formidable obstacle in the way of rapid transmission.

The electro-static capacity of a line is its capacity to hold current, and this capacity has to be satisfied before a signal can be manifested at the distant station, and the charge left in the wire after the signal has been delivered must be discharged to ground or neutralized by a reverse current before another signal can arrive. The electro-static capacity of a wire is increased by its envelope, whether it be air, or insulating material. The static discharge after each impulse runs out at the ends of the wire, about two-thirds coming back to the sending station, and one-third following the signal impulse on to the receiving station. The portion coming back is an obstacle in the way of the next signal, and the portion running out has the effect of elongating the signal which it follows, and if the signals are too close together and the wire long enough, they will appear on the recording tape as a solid line without definition, so that letter p, comprising five dots, would look like letter l, which is a long dash. The remedies for this very troublesome obstacle in the past have been transmission of reverse impulses after each signal, so as to neutralize the static discharge in the line, or connecting the line to ground after each signal, so as to let the static run out. Another way was to put artificial leaks or partial grounds at different points along the line and work over them by surplus power.

The first of these remedies is the only one that is practically effective, as the static discharge can be neutralized in about one-tenth of the time taken for its discharge to ground.

Fig. 8.—A represents a record at a speed of 300 words per minute over a line ten miles long having very little, or inappreciable static capacity

B represents the same word at the same speed over a line 100 miles long, and having considerable capacity.

C represents this word over a line 500 miles long.

The improvement referred to for remedying this trouble consisted of an arrangement for differentiating the dots from the dashes, putting them in different lines, and making two marks for a dash to further distinguish it from an elongated dot or a series of them, so that the blurring or "tailing" effect might be disregarded to an extent which doubled the speed of transmission.

In drawing comparisons between this system and the latest method of rapid telegraphy, it may be said that this had the dis-

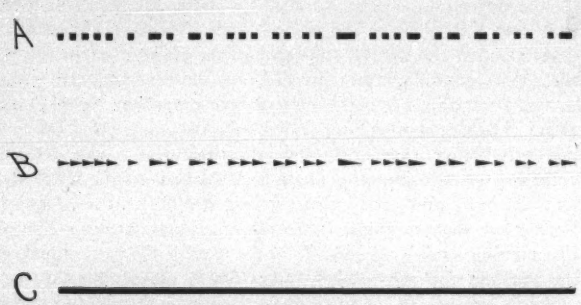


Fig. 8. 3 samples tape A B C.

advantage of requiring a three-keyed perforator, somewhat similar to that used in the Wheatstone System for preparation of tapes, and consequently, necessitated special training of operators, and also required the use of the continental code or modification of the American Morse Code.

Coming now to Rapid Automatic Telegraphy of to-day, adapted to all distances and conditions, it will be seen that in the formation of dots the static discharge is *neutralized* by reversals, and *utilized* for completion of dashes, which are really dot impulses, supplemented by the discharge, and when under certain conditions, the discharge from the line is not sufficient to draw out the dash to the required length, it is increased by adding "capacity" through the medium of a condenser between the line and ground.

Fig. 9 is a diagramatic representation of the Telepost circuit.

The sending tape T shows two rows of perforations. Each signal, dot or dash, is represented by two holes, one in the lower row, the other in the top row. Positive impulses are made through the lower row, negative impulses through the top row. All the positive impulses make a record on the receiving tape R.

The negative impulses from the upper row do not record, being represented by the spaces between successive dots.

The pairs of perforations representing dots are just out of perpendicular, so that in passing between the contact fingers of the transmitter they will not bridge.

The contact fingers F pressing on top of the tape are electrically one and are connected to the line, the contact fingers pressing up-

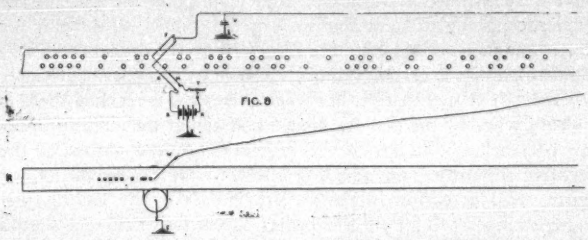


Fig. 9. Telepost circuit.

ward underneath the tape are separate, C, being connected to the positive current, B, while H is connected to the negative current, K. The battery is grounded in the middle at G. When the tape is drawn by the motor M (not shown), and the lower hole allows contact fingers, F and C, to come together a positive impulse is sent over the line and is recorded on the receiving tape R as a dot. When a hole in the upper row permits contact, F and H, to come together a negative impulse goes over the line, but it makes no mark on tape R. It performs useful work, however, in preventing the positive dots from running together on the receiving tape. In the case of a dash, the positive and negative holes in the tape have a greater angle. The negative does not follow the positive immediately, as in the dot. It is set back a distance representing a dash; therefore, while the contact fingers, F, C, are separated by the tape some of the static charge is running out at the

receiving station and continues the mark which started with the dash impulse until the contact F, H come together in the delayed upper hole and a negative impulse is sent to cut off the dash at a corresponding length. It will be understood that the record on tape R is made by electro-chemical action. The tape R is dampened with ferro-cyanide and certain other chemicals, which when acted upon by a positive electric current decomposes the iron recording wire W, leaving an indellible mark. Now, as already stated, where there is not sufficient discharge at the receiving end of the line the condenser V can be regulated to make up the deficiency. This condenser is charged at the same time as the wire, and its discharge follows up the signal impulses so as to prolong the "tailing" on the receiving tape. If a few miles of underground cable were included in the circuit, they would take the place of the condenser, going to show that underground lines, so difficult for electro-magnetic telegraphy, are conducive to the operation of this rapid system up to certain limits. Of course, it is possible to have an excess of static capacity, but when this point is reached there is a means whereby the best results possible under the circumstances can be reached. It lies in the regulation of the power of the negative impulses, and adapting them to the requirements for density and definition in the record. With a line having just enough capacity to fill out the dashes, the negative current should be considerably weaker than the positive. If of equal strength, the recorded impulses would be too short and faint. If on the contrary there is too much capacity the negative current may be strengthened. The regulation of the negative is effected through the adjustable resistance shown. (Y Fig. 9.)

It will be seen that in this system three very important factors are combined for obtaining the best results from a telegraph curcuit, viz., first, a positive current sufficiently powerful to make the record electro-chemically in the shortest possible time. Second, a regulable source of Electro-static capacity for use where the normal capacity is not enough to make a dash. Third, adapting the power of the negative current to the electro-static capacity of the line, normal, or artificially augmented, to give the record the maximum plainness consistent with safe separation of the characters, so as to make transcription easy and accurate.

It is thought that in this organization is reached the highest signalling efficiency for all conditions of lines, overhead, under-

ground, long or short. There are no electro-magnets to energize, no armature to actuate, no inertia to overcome, or electro-mechanical work to do. The chemically prepared tape is a part of the circuit, and the characters are made simply by the current passing through it. Once installed on a line, there is practically no adjusting to do. A change in weather conditions sufficient to put out of operation any electro-magnetic system does not seriously interfere with the electro-chemical. Half the current might be suddenly diverted during transmission without loss of any of the characters. The record would be fainter, but no impulses would be missing.

The system can be superimposed on a telephone circuit and worked simultaneously with telephony at about two-thirds of its independent speed.

While our time has been taken up with the main electrical methods, it may be said that there are numerous features of operation and control which are indispensable for practical commercial telegraphy. The demonstration will show that as the tape bearing the message comes from the perforator it is automatically wound upon a reel, and whether there be one or a dozen messages, or 500 words to press, the tape is a single unit, and goes through the transmitter last end first.

At the receiving station, the tape is also wound upon a reel which brings it right end first,—for transcription. The received tape is drawn in plain view of the transcribing operator by means under his own control, not continuously moving, but in fixed steps, so that it is at rest while being read. The receiving machine is under control of the transmitting station. When the transmitting lever is put down to start the tape, an impulse is sent which starts the receiving tape. When the transmitting tape runs out another impulse is automatically sent which stops the receiving tape. Should the receiving operator wish to stop the transmitting machine he can do so, and the transmitting operator can stop the receiving machine at any stage. Should the wire come accidentally in contact with another both machines would be thrown out of operation.

Fig. 10 shows the message being composed on the tape by the ordinary Morse key.

Fig. 11 shows it going through the transmitter (cut omitted).

Fig. 12 shows reception of the message on the chemical tape.

Fig. 10. Perforating by Morse key.

Fig. 12. Rapid Receiver in operation.

Fig. 13. Transcribing from rapid tape.

Fig. 14. Reading by sound from received perforated tape.

Fig. 13 shows the received message on the transcribing table.

Fig. 14 reading by sound from perforated tape.

Fig. 15 shows specimen of a recorded telepost message at 1,000 words per minute over a line representing 500 miles, 1,000 ohms, 2½ microfarads, with 110 volts.

At this speed eighty-two persons would be kept busy over a single wire, forty perforated messages for transmission, forty transcribing them by typewriter, and two machine tenders. This would be more than the equivalent of forty Morse circuits as at present operated.

It is only by the utilization of the full facilities of a wire that a Telepost service can be established. Cheap rates are impossible at nine words per minute. At 500 to 1,000 words per minute low charges can be brought to apply to ordinary correspondence now sent by rail. When a letter of fifty words filed in the Telepost office in Philadelphia can be dropped in a post office in Chicago, or any other city, within half an hour for twenty-five cents, an

Fig. 15. "The Telepost" tape.

enormous traffic will be speedily developed. It will be entirely feasible for business houses or newspaper correspondents to compose their letters or reports on a tape in their own offices by keyboard machine, send the tape in a roll to the Telepost office, where it will be forwarded without delay, and have the record tape delivered to the party at the other end, for private transcription. In this way correspondence would be absolutely private, for if desired, the perforated tape could be returned to the sender. Here the telegraph toll would be merely nominal.

There is nothing now between the high-priced telegram and the two-cent stamp, of which over one hundred millions of dollars worth are used yearly. The argument of the telegraph companies has been that telegraphing is an emergency business. People only use it when compelled to and then are willing to pay the price. This position is in strong contrast with every other art or industry, and must surely give way to a more enterprising policy, and all correspondence of any importance whatever will be telegraphed. Words will go by wire instead of by train.

To restrict the use of a wire by working it at from nine to forty words a minute when it is capable of carrying 1000 words, is wasteful.

To put a letter in a bag, cart it to the train, haul it a thousand miles, and then cart it to the post office, is slow.

Between these two methods of communication, it is thought there is room for the Telepost.

NOTE.—During the lecture 100 words per minute were transmitted by the Electro-Magnetic Automatic System and reproduced in perforations on a tape at the receiving station over an artificial line representing 500 miles. The reproduced tape was then put in a local sounder circuit and the message ticked off in perfect Morse at speeds ranging from ten to sixty words per minute.

By the rapid Automatic System 1,000 words per minute were transmitted over the same circuit and plainly recorded in Morse characters on a tape.

SAFEGUARDS FOR MINES.

The coal mine death roll in Pennsylvania during 1906 was 500; 250 died as the result of gas or dust explosion. In West Virginia in the same year mine explosions cost 88 lives, and in the early months of 1907 the list of fatalities was increased by more than a hundred more.

That the United States is far behind European countries in safeguarding the lives of its miners has already become evident from the investigations now being carried on under the direction of J. A. Holmes, of the United States Geological Survey; but determined efforts are now to be made to bring about better conditions at the coal mines, to stop the appalling sacrifice of human life, and incidentally to lessen the waste of fuel in mining operations.

A series of unique experiments is about to be undertaken by the fuel division of the Survey, with a view to determining the safety of the various dynamites and powders used in blasting in the presence of the deadly firedamp and perhaps equally deadly coal gas. The explosives which stand the severe tests for which plans are being made will be classed as "permissible explosives," and their use will be urged upon the mine owners of the country.

The experimental station which is to be established as the basis of the proposed tests will be under the direction of Clarence Hall, the explosives agent for the Government. Mr. Hall has recently returned from England and Belgium, where he examined the splendid experimental stations that have there been maintained for years. In these and other European countries the miners, the government, and the manufacturers of explosives cooperate in the effort to prevent such casualties as those by which this country has recently been horrified. The English experiments have resulted in

establishing a number of "permissible explosives," whose use by the miners is compulsory. English miners are also restricted to a limit charge, for exceeding which a severe penalty is imposed. In the coal-mining States of this country protective regulations for the use of blasting materials are few, and in many States no attempt is made to control the kind of powder used.

The experimental station in Belgium was intensely interesting to Mr. Hall, the gases used in the tests coming from an abandoned mine. In a test of safety lamps witnessed by Mr. Hall at this station the lamp most generally used in the mines of the United States behaved the worst, igniting the gas each time. A self-igniting lock lamp made in Germany proved the best.

Another line of investigations to be carried on by the Survey will relate to rescue work. It is declared that in serious gas explosions in mines many lives could be saved were it possible for the rescue party to enter immediately after the accidents. As it is now, the deadly fire-damp often holds the men back for hours while their comrades are slowly being suffocated or burned to death. At the Belgium station Mr. Hall found an apparatus capable of sustaining life in the midst of fire-damp or among the poisonous vapors that follow mine explosions. The apparatus will be tested in the miniature coal mine which will be fitted up as a part of the experimental station, and if the tests are successful its use will be strongly urged.

It will not be possible, of course, to compel the adoption of safety regulations or appliances; but miners and operators will be invited to witness the tests, and the results of the investigations will be given to the public in the hope that great good may follow.

The location of the experimental plant has not been definitely decided on, but it will probably be in the Pittsburg district, and Mr. Holmes states that the work of erection will be begun within a few weeks.

TWO WATERS FROM ONE WELL.

A flowing well from which both fresh and sulphur waters are obtained—one of the wonders of Logansport, Ind.—has recently been visited by a member of the United States Geological Survey who is making a systematic study of Indiana well waters.

The well is in Riverside Park and was drilled by the city two years ago. An eight-inch pipe was sunk to a depth of eighty feet, and inside of it a five-inch casing was placed. Fresh water from a bed of limestone comes up between the two pipes, and water which tastes and smells strongly of hydrogen-sulphide gas comes up through the five-inch pipe from a lower stratum in the limestone. The sulphur water flows with a volume of about a gallon a minute from the drinking fountain, while the fresh water flows with a somewhat smaller volume from the pipe about twenty feet away. Thus the visitor to the park can have his choice of drinks. Samples of both waters were collected by the geologist and shipped to the laboratory of the Survey at Washington, D. C., for analysis.

The only similar well known is situated about fifteen miles north of Cincinnati, Ohio, but the Ohio well is non-flowing.

Working Standards of Light and Their Use in the Photometry of Gas.

(Paper read before the Franklin Institute, January 9, 1908.)

By Chas. O. Bond.

This paper will deal with such standards only as are generally used in testing the illuminating value of gas produced in this country.

It is well first of all to define clearly what is meant by the Unit of Light as understood by gas people. It is the average light, measured in a horizontal direction given by Parliamentary sperm candles prescribed by the British Metropolis Gas Act of 1860, said candles to be six to the pound and burning 120 grains per hour. This, of course, would not refer to one candle but to the average of many candles; for candles differ in light giving value over a considerable range. This Unit, it is clear, could not be definitely set aside for reference until there appeared a light source of sufficient constancy to be competent to preserve this Unit when once its value had been incorporated in that source.

The first lamp which undertook this office was the Pentane Air Gas Flame, devised by A. Vernon Harcourt, this flame being maintained as seen by the screened eye at a constant height of 63.5 mm. and the fuel supply coming from a definite mixture of air and pentane vapor contained in a small holder. This flame was naked, of approximate shape of the candle flame and received its fuel without the intervention of a wick. Furthermore, its value through height regulation had been so adjusted as to give a light exactly equal to the average of many candles. This is an important point, for in later years when the effects of atmospheric changes upon the various flames were studied, it was seen that these two flames being so similar, would be nearly if not quite equally affected.

The London Board of Trade Committee on Photometric Standards, appointed in 1891 and reporting in 1895, were so confident of the worth of the Pentane Air Gas Flame as to state:

"5. We find that the one candle light flame proposed by Mr. A. Vernon Harcourt as giving a standard light and commonly known as the 'Harcourt Pentane Air Gas Flame,' when used under the conditions defined, does constitute a very exact standard, capable of being reproduced at any time without variation of illuminating value.

"6. We have satisfied ourselves that the light given by Mr. Harcourt's above mentioned pentane air gas flame as defined, in respect to the conditions of its production in the Appendix (Sec. III) is a true representative of the average light furnished by the sperm candle flame constituting the present standard." * * *

The elaborate determinations covering a period of thirteen years over which this pentane air gas flame had been tested against the average candle and from which the Board of Trade Committee satisfied themselves were as follows:

Date.	Observers.	Value of air-gas flame in standard candles.
1879	Vernon Harcourt	.994
1879	Livesey and Brown	.990
1881	H. B. Dixon	.998
1887	British Association Committee	1.016
1888	British Association Committee	1.006
1891	Greville Williams	1.008
1891-2	H. B. Dixon	.998
	Average	1.001

These facts and quotations are cited because it has been the custom for the illuminating gas industries of this country to follow the methods set by the London Gas Referees, especially in photometric affairs. So that, while in 1895 the Unit of Light still officially resided in the average sperm candle, there existed another source where one could go and obtain its value far more readily. Yet this air gas flame with its attached holder lacked the portability of the candle, and so another effort was made to place the Unit in safe but portable keeping. Mr. Harcourt proved to the satisfaction of the Referees that he had devised such a lamp in 1897, called the Ten Candle Pentane Lamp, and the Referees adopted it at the assigned value of ten standard candles.

If custom is to be followed, therefore, the Unit of Light as understood to-day by the illuminating gas industries of the United States is one-tenth of the Harcourt Ten Candle Pentane Lamp. There are in use in this country to-day over 150 such lamps, or American reproductions of them, and their use is extending rapidly. It is a good indication that the American gas industries desire a more intimate acquaintance with the Unit, in order that more accurate photometry may result.

Standards of light are of three kinds: Primary, secondary and working. A primary standard is one that may be built and operated from a written specification. The chief quality desired is reproducibility, even if this has to be attained by infinite pains and for a short time only.

A secondary standard, once calibrated against a primary standard, must have the quality of constancy. It should also, if possible, be inexpensive, portable, and easy to set up and operate, but not necessarily reproducible.

A working standard, as its name indicates, should be one adapted to the work in hand. It may be calibrated as often as desired or as is necessary.

Until recent years the gas industries of this country largely used the candle for each of the four purposes defined above; it was Unit, primary, secondary and working standard all in one. And it may be said that the nearer a standard can come to fulfilling all these conditions accurately the more ideal it will be, except that the Unit is small for practical measurements.

With the exception of Violle's suggested primary standard, which is the light emitted from a square centimeter of molten platinum at the temperature of solidification all the other feasible primary standards have depended upon incandescent carbon for their luminosity. This carbon may be in a fixed position and rendered incandescent by the molecular agitation produced through an electric current, or it may be in a free stream gaining its luminosity through the application of heat as in flames.

The attempt to preserve luminosity constant in flame standards is made in either of two ways: (1) by a uniform consumption of fuel, or (2) by the maintenance of a constant flame height. Granted a fuel of definite composition either of these methods would probably succeed were it not for changes in the atmosphere supporting flame combustion. The luminosity of the carbon

particles, and consequently of the flame, is said to vary as the fifth power of their absolute temperature. Changes in the atmospheric component of the gaseous fuel mixture will therefore produce variations of flame temperature and hence of luminosity.

So that, with the greatest care in specifying the construction, operation and fuel for these primary standards of the flame type it has not been possible to secure the reproducibility of a given light value to within less than a range of three per cent. The Reichsanstalt in Germany will certify lamps (Hefners) that come within two per cent. above or below as regards their light value as compared with that of the standard lamp.

Out of sixty-four pentane lamps that have been standardized by the Photometer Department of the Philadelphia Gas Works eight have fallen more than one and one-half per cent. from the normal as compared with an imported English Pentane lamp certified by the Secretary of the London Gas Referees, and three of these were found to have done so through faults in construction. As indicative of the constancy of pentane lamps upon intercomparison I will cite an instance: English Lamp, No. 51, was imported from London in January, 1900, having an ascribed value of 10.0055 candles, sealed and certified by W. J. A. Butterfield as compared with one of the lamps proved by the Referees to give a value of ten candles. On May 13th, 1904, this English lamp 51, (value 10.00) imparted a value of 10.04 to American lamp No. 2 as an average of sixty readings. On May 17th, 1905, American lamp No. 2 (10.04) imparted a value to American lamp No. 89 of 10.02 as an average of 100 readings.

In the summer of 1907, this American lamp No. 89 was taken to London, its value being unknown to the London Referees, and it was compared with one of their proved lamps of ten candle value. Upon this test American lamp No. 89 had ascribed to it a value of 9.99 candles as against the above-mentioned value of 10.02, which it bore from calibration on this side of the water. This is a remarkable agreement, there being a discrepancy of only 3/10ths of one per cent.

It is apparent that the pentane lamp has the quality of constancy and is therefore able to act as a vehicle in conveying a given value to any of our working standards in gas photometry. Being constant for a given atmospheric condition, the original lamp in London may also be depended upon to maintain accur-

ately the Unit of Light value. From these two considerations we see that it is now possible by means of good working standards to measure the quality of our gas in terms of the true English Unit of Light.

We will now consider the qualities which should be possessed by the ideal working standard and then proceed to the discussion of those working standards which are in general use in America. These requirements are:

1. That it should be readily portable, of simple construction and operation, and of unvarying dimensions.

2. It should have an independent fuel, reasonable in price and readily procurable, of definite chemical composition with a fixed boiling point.

3. The flame should be of the same order of luminosity as the test flame; of a similar color; fed without a wick; at a constant pressure, through a constant opening; and no chimney should intervene between it and the photometer disc.

4. The lamp should be burned in a quiet, adequately ventilated room of uniform temperature and be supplied with pure air of the same temperature. After reaching thermal equilibrium its flame height should be set and all the conditions named above having been complied with, the flame height and flame value will remain unchanged for that particular atmospheric condition.

5. It is known that all flames being supported in combustion by atmospheric oxygen are influenced by the condition of that atmosphere as regards carbonic acid content and water vapor content. It is desirable; therefore, that the luminosity of the standard used should, as far as possible, be influenced in the same direction and to the same extent as the test flame. In this way the correction in value is automatic.

COMMON WORKING STANDARDS.

Reports were received by the American Gas Institute from the gas companies in about eighty of the largest cities of the United States, showing the following working standards to be in use:

A. British candles of several importations. Used by thirty-one of the forty municipal and state inspectors, and by forty-one gas companies.

B. Edgerton Standard, used by eighteen gas companies; no municipal or state inspectors.

C. Hefner lamps, used by one municipal inspector; five gas companies.

D. Electric incandescent lamps, used by two municipal inspectors; no gas companies.

E. Elliott lamp, used by eleven gas companies.

F. Pentane Lamp, used by thirty-one gas companies and three municipal inspectors.

G. Jet Photometers, variously manipulated, used by twenty-eight gas companies, twenty of which also use bar photometers.

Of these working standards we may eliminate from consideration D (electric incandescent lamps) and G (jet photometers); D because no companies use it and for the reason that it is unaffected by atmospheric changes and so is unsuited for testing gas flames which *are* so affected; G for the reason that while by flame phenomena it serves to indicate the direction of change in candle power and can be calibrated fairly well, yet in the true sense it is not a photometer and makes no use of the light standards under discussion. In justice to the electric incandescent lamp it should be said that it is to-day the most trustworthy custodian of the Unit of Light, and is employed at the Bureau of Standards for that purpose.

A. *Candles.* As a working standard these have back of them the weight of long usage, of being mentioned in many contracts, and of general adaptability. They are still in the lead, numerically, as a standard. They possess a light of correct color, they are cheap to transport. This is all that can be said in favor of them as a working standard. There is no doubt that the name "candle power" has had much to do with their retention. In single determinations, which is the function of a working standard, they do not prove constant. Hence, gas companies must allow a safe margin for their vagaries. Their average variation above and below normal as thoroughly observed by the Dutch Photometric Commission was 2.87%, and individual variations were over 9% above and below normal.

Furthermore, the users of candles in this country are now in an anomalous position. One requisite in the past to make a candle of official value was that it should be certified by the London Gas Referees. For several years now the pentane ten candle lamp

has been the official standard in England and it is not likely that the Referees are still certifying candles; yet we import them and trust to their being made in accordance with specifications. The last specifications for the purpose of securing uniformity in their manufacture were issued in 1894 and these were so minute that they have rarely been complied with by the manufacturers.

Not only is the candle specified,—its weight, buoyancy, composition, material, wick, method of plaiting wick, its ash by weight after burning, melting point of sperm, etc.,—but a rigid method of burning them is laid down. In the warmer and more humid parts of this country it is next to impossible to comply with these regulations for burning them. They are particularly susceptible to the influence of moisture in the air, and in the warm days of last summer we made the attempt to put this humidity influence in the shape of a formula.

For Philadelphia, using the short candle of the "B.T.S." brand, we would say, Candle Power $= 1 + .0087\ (9.3 - e)$, where 9.3 litres of water vapor per cubic meter of dry air is normal, and where "e" represents litres found present. It is not expected that this formula can be applied to individual readings, but only to averages of a considerable number.

Mr. H. G. Bishop, of Baltimore, has furnished me with data concerning the grains of sperm consumed in ten minute intervals, extending over a period of eight years and averaged by months. This shows the effect of humidity very well.

Jan. 40.08	Feb. 40.07	Mar. 40.42	Apr. 40.55
May 40.42	June 39.18	July.....38.77	Aug. 38.62
Sep. 39.46	Oct.....39.94	Nov. 39.82	Dec. 40.05

These are the results from large averages, running from 120 to 235 determinations in each monthly classification, so that all wide variations are smoothed out. The normal consumption of sperm for a ten minute interval is forty grains, and readings are discarded where the sperm consumption varies more than five per cent. from the normal. As seen from the above figures the average consumption for the month of August is 3.5% below normal; so there must have been days, even in latitude 40° North, when it would have been impossible to secure a determination using candles if they had burned in normal accordance with humidity conditions. It would be rather discouraging to try all day for a

correct determination of candle power with the certain knowledge that if the humidity did not decrease none could be obtained. The remedy would seem to lie in enlarging the limits of permissible variation from the forty grain rate. But as the case stands, if the candle is accepted for a working standard the method of its use must be accepted also.

Candles imported from different sources differ in value, this difference being in some cases as much as seven per cent. The number of threads per strand of the wick differ, the melting point varies, the curvature of the wick during burning has an important bearing on the luminosity of the flame, its temperature being affected.

In spite of these damaging facts many people have an abiding faith in the accuracy of these candles as a working standard, and when in comparison with some other standard there occur irregularities, they are quick to attribute them to the other standard. In order to cover this phase of the argument I selected from thirty boxes of candles one candle each, and, arranging them in pairs, tested the fifteen pairs against each other in a comprehensive manner. In this way I obtained the average relation existing between the pairs and found that the highest variation above this was 11.5% and the lowest was 7.5% below. It is plain, therefore, that the fault lay in the candles themselves.

Finally, it cannot be claimed that the manipulation of the candle in making the determination of illuminating value is either simple or easy. There is the trouble of cutting it in two and waiting for the cups to form properly; its adjustment of flame axes to a correct position and distance from the light under comparison, for the wicks twist about as they unbraid; the nice adjustment of the balance and the anxiety of watching for it to turn; the flickering of the flame caused by the minutest draft; the necessity of raising the candles in their holder as they are consumed.

For the reasons enumerated above it is difficult at this time to justify the use of candles as a standard of light except when the average of a great number of determinations is used; or when little accuracy is required; or when the place of test is so remotely located as to make other standards not feasible, or else legislative or contract obligations force their use.

B. *The Edgerton Standard.* This is a development from the Methven screen, much used in England as a secondary standard.

Methven claimed that if a coal gas flame burning in a Sugg D Argand burner was kept at a constant height of three inches, there was a zone in that flame which was of great constancy and brilliancy. He erected a screen about $1\frac{1}{2}$″ in front of the axis of this flame containing, at the height of this zone, a slit about 6 mm.

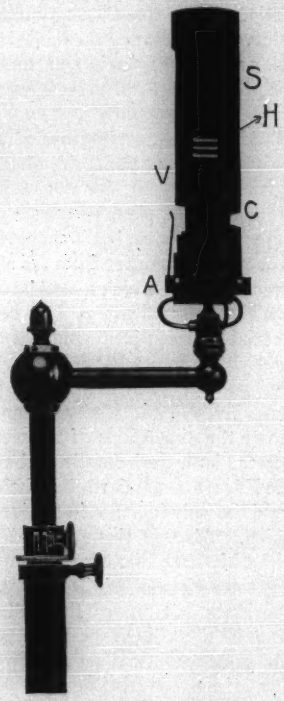


Fig. 1. The Edgerton standard.

wide and 25 mm. high, through which a light of two candles was supposed to issue.

The Edgerton Standard burner consists of a Sugg D Argand burner, with a 7″ x $1\frac{3}{4}$″ chimney surrounded by a blackened brass sleeve. In the front of this sleeve with its lower edge $\frac{1}{8}$″ above

the top of the steatite ring of the burner, there is cut a slot 13/32″ high and of such width as to include the entire diameter of the flame. The theory of the standard is, that if the flame be adjusted to a height of three inches the horizontal section visible through this slot will remain practically constant in candle power for ordinary variations in the illuminating value of the gas supplied to it. The sleeve in the rear of the flame is also cut away so as to prevent interior reflection from it, and small side slits are cut in the sleeve at the proper height to observe whether the flame is kept constant at three inches height.

Edgerton seems to have made an improvement on the Methven Screen in having his slit disclose the entire diameter of the flame instead of only partially doing so; for the radiant center of the Methven standard is not in the plane of the slit, nor does it lie at the geometrical center of the flame, but it changes for each change in the distance of the photometer disc from the standard.

If, in using a screen through which a standard light is to issue, the aperture be made very small the radiant center of the light may, without appreciable error, be considered to lie at the slit. If, however, the aperture be somewhat enlarged, and if the photometer disc be placed quite near, as it would be with the light of only two candle value given by the Methven standard, then as the disc was moved closer the dimensions of the section of the flame exposed would increase both horizontally and vertically.

In the case of the Edgerton standard the whole diameter of the flame is exposed, and the only increase in sectional area would be in a vertical direction. Also, as this standard gives more than twice the light of the Methven, the error from this cause would be reduced by the greater distance of the photometer disc. As a matter of fact experiment has proved the radiant center of the Edgerton standard to lie 9/10″ in front of the geometrical center of the flame, and the same result was deduced by formulæ worked out by Prof. Jacobus, of Stevens Institute.

In using the Edgerton, therefore, its geometric center is placed 9/10″ back of the usual standard line, and it is standardized in this position.

Some experiments showing the light value of the Edgerton Standard under different conditions are detailed in a paper by Mr. Rollin Norris, published in the 1899 Proceedings of the American Gas Light Association. The fuel supplied to this

standard was either straight coal gas or straight carburetted water gas, but not a mixture. When water gas was used, the value of the Standard varied from about 5.70 to 6.30 candles; when coal gas was used of a candle power as shown on a flat flame burner as being between 13 and 17, the value of the Edgerton varied from about 4.20 to 4.60. It is evident that a mixed gas would give values, uncertain with varying proportions of the mixture, falling between those figures.

When water gas was used there seemed to be no fixed relation between the candle power of the fuel supply and the value of the standard resulting; when coal gas was used there was an increase of about 1/10th candle in the value of the Standard for each candle increase in the value of the gas supplied. The effect of variations in the flame height may be seen from the following data:

Height of flame in inches.....	2.5″	2.75″	3.00″	3.25″	3.50″
Average C.P. of Edgerton Std....	6.52	6.42	6.31	6.21	6.11

Mr. Norris concludes that with either coal gas or water gas, if the Edgerton be carefully standardized for the conditions under which it is to work it may be relied upon to give results whose error does not exceed 1½ candles, while a large majority of the observations will be correct to within one candle of the true value of the gas.

In the use of this standard it is imperative that the chimney shall be kept clean and that the calibrated section of it be always presented to the opening in the screen. As the sleeve completely surrounds the glass chimney the latter gets much hotter than if it were exposed to the air, and if by neglect the flame lengthens for a time so as to fill the chimney, it is likely that the glass will be melted down.

The simplicity, ease of operation, cheapness of maintenance, and rapidity of preparation of this working standard have in the past made it very popular about gas works. It has been valuable in direct proportion to the care taken to make and keep it accurate. Many works have it in position and standardize it frequently from a pentane lamp. If coal gas can be furnished to it through an averaging tank to prevent large and rapid changes in the quality of the gas, it forms a valuable adjunct to the operating department.

C. *The Hefner Lamp.* This standard is little used in America

among gas companies, and personally I am not as yet familiar with its operation. Without doubt this lamp has been described before this Institute already. The literature relating to it is full; it has been more thoroughly investigated than any other light standard, and is the equal in reproducibility of any of them. It is simplicity itself, and readily portable. The greatest credit is due to those scientists in Germany who have perfected its construction and method of operation. Yet there would seem to be good reason for its non-adoption as a *working* standard in America. It is, first of all, a Primary standard of light, that standard being the German Unit and not the one which we follow. It has a value even less than that of our candle, being about 9/10ths of it, and our candle used singly is too small for working purposes.

With a magnifying flame gauge the Hefner flame height is set at 40 mm., for the lamp is constructed to be normal at a stated height of flame and not for a stated consumption of fuel. This height is difficult of attainment, for the flame tip is very pointed, and eyes differ in its observation; an error of 1 mm. in flame height causes an error of 2.5% in the light emitted. The flame, moreover, is of a distinctly reddish color, less suited to match the gas flame in disc comparisons than is the candle flame. It is very sensitive to drafts; more so probably than candles on account of the obstruction which its base presents to a vertical flow of air currents to the flame; and as accurate flame height is the great desideratum this objection becomes more important than it otherwise would be.

The lamp is operated with a wick, which is adjustable in height and which supplies the fuel, amyl acetate, to the flame.

E. *The Elliott Lamp.* This lamp was contrived by Dr. A. H. Elliott, of New York City. It is the adaptation of the student lamp principle to the purposes of a secondary standard, the fuel used being a high grade of petroleum, usually Pratt's Astral oil. The wick is flat, and a screen is placed close beside the flame with an opening of the requisite dimension to permit the passage of a ten-candle light to the disc. The glass chimney is large, round and bulbous so as to allow the presence of the screen inside it without undue deflection of air currents. The screen being placed so near the flat flame and its opening being of relatively large size, the standard does not require a similar correction for radiant flame center as does the Edgerton Standard.

The lamp is painted black, and has an acorn-shaped reservoir capable of holding about 500 c.cs. of oil and the rate of consumption of oil when burning normally is about 1 c.c. per minute.

The wick is $1\frac{1}{2}''$ wide, and instead of being trimmed horizontally across its entire top, the two corners are cut diagonally, leaving a horizontal top of $1''$. This has the effect of producing a flame with a level top and vertical edges. A tin form is supplied which fits snugly over the end of the wick, indicating the direction of trimming. The trimmed end is then lightly touched with a flame while still dry, to singe off the unevenness and fluff occasioned by the scissors. The wick is then placed in position and run up and down the channel its whole length to make sure it works freely. The reservoir is then filled and after about five minutes the wick is saturated and ready for lighting.

The burner is provided with an extra high dome through which the flame issues, and to this dome is attached a screen, consisting of three parts: two uprights at the sides with a space of $1\frac{1}{2}''$ between them, and an adjustable plate connecting them above. This plate is four inches high and its lower edge is set at a height of about $\frac{1}{8}''$ above the center of the dome. The screen is made adjustable in a vertical direction so as to permit an increase or decrease in the exposed length of flame necessary to produce ten candles.

The lamp having been lighted and chimney placed, the wick is then turned up until the opening in the screen as observed from the photometer disc is a luminous whole with the exception of the blue flame at the bottom. Right here the greatest care must be observed to get a level topped flame. After burning twenty minutes so as to gain thermal equilibrium the lamp is ready for standardizing and subsequent use. It should not be touched again, and it will continue to give a remarkably constant light until the reservoir is depleted. If exactness in the preparation and manipulation of the wick is observed the lamp is fairly reproducible at ten candles for a limited time. It is claimed that a wick will last about 200 hours before capillarity is impaired, but the usual errors incident to the use of the same are soon encountered, and the safest method is to standardize the lamp frequently.

Following are light values obtained over a considerable period for the Elliott lamp as compared with a pentane lamp, the above method of adjustment being used:

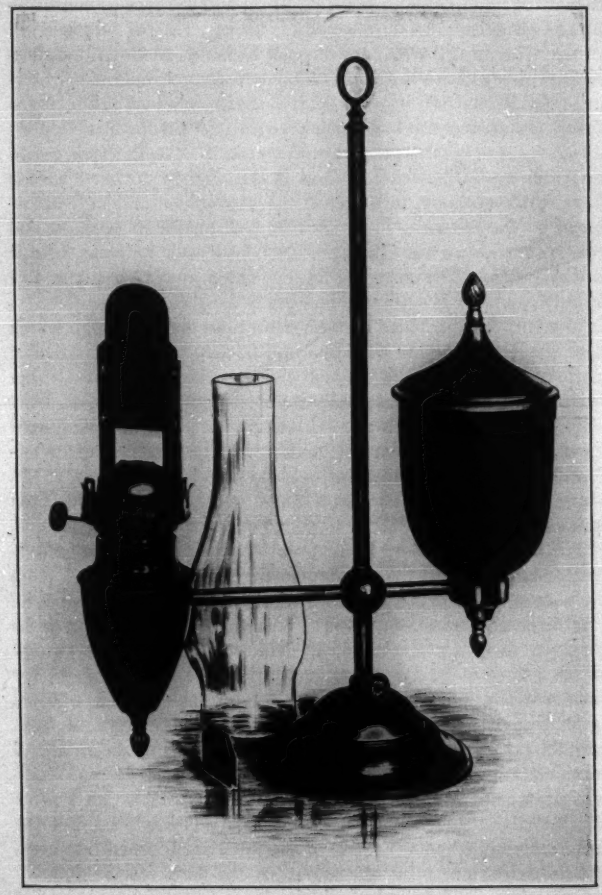


Fig. 2. The Elliot lamp.

Date.	No. Readings.	Value.
3/23/'07	11	9.945
3/25/'07	18	10.044
3/26/'07	36	10.292
3/27/'07	16	10.194
3/28/'07	36	10.11
	117 Avg.	10.117

Another series of readings was begun on April 17th lasting until April 23d, a total of 550 readings being taken, and the average value given the lamp, the positions of the contrasted lamps being reversed half the time was 9.957. The lowest value was 9.76 and the highest value was 10.21.

An experiment to determine the error introduced by disturbing the height of the flame was made:

	Correct height.	¼″ low.	¼″ high.	½″ high.	Correct height.
Value vs. pentane lamp.....	9.922	10.172	10.647	11.243	9.831

This shows most forcibly the necessity of having the wick so trimmed as to have a level top to the flame for accurate adjustment. If such care is given the lamp it may be classed as equal to the Edgerton Standard (with the further advantage of having an independent fuel supply) and as better than the candle for secondary work.

During the summer of 1907 the Elliott lamp and the pentane lamp were subjected to the influence of vitiated atmosphere in a closed room. The loss in illuminating value was attributed in each case to vitiation, though of course by the use of proper apparatus it would have been possible to separate the effect of the carbonic acid, the water vapor and the diminished oxygen effect. In reality these effects are always present together and it would seem that the inclusive term "vitiation" is more proper, and that the CO_2 content is a fair measure of it.

In these tests the Elliott lamp and Pentane lamp having approximately the same value, suffered about equally for a given per cent. of vitiation, while the candles suffered much more.

F. *The Pentane Lamp.* While something has been said of this lamp under the discussion of the Unit and Primary standards, it is proper that an instrument of its importance in the world of

physics should be accurately described, both in construction and operation. I quote from W. J. A. Butterfield's extract of the Referees' Method:

"Air is saturated with pentane vapor by passage through a saturator, which is about two-thirds filled with pentane, and the air gas so formed descends by its gravity to a steatite ring burner. The saturator is 184 mm. square and 38 mm. deep, and contains seven partitions soldered to its top, and alternately meeting either side and stopping 25 mm. short of the opposite side. The air is thus compelled to pass eight times across the saturator. A piece of India rubber tube, 13 mm. wide internally, conveys the air gas from the saturator to the burner. The air inlet pipe to the saturator, and the air gas outlet are provided with stop cocks, and the height of the flame is controlled by the outlet cock. A brass chimney 431 mm. long, 30 mm. inner and 32 mm. outer diameter, is placed so that its lower end when cold is 47 mm. above the steatite burner. This chimney tube draws the flame to a definite form, and hides the top of it from view. A mica window in the tube allows the tip of the flame to be seen, and the height to be regulated, so that the tip is somewhere between the bottom of the window and a crossbar. A tube, 290 mm. long and 50 mm. inner and 52 mm. outer diameter, surrounds the chimney tube, and draws in air at its base. The chimney tube projects 65 mm. below and 76 above this outer tube. The heated air passes from the top of the outer tube to another tube 529½ mm. long and of 23 mm. inner and 25 mm. outer diameter, which is placed parallel to the first tube, and with its axis 67 mm. distant from the axis of the latter. From the bottom of this tube the air passes to the center of the steatite ring of the burner. The outer diameter of this ring is 24 mm., the inner diameter 14 mm. and there are 30 holes, each 1.25 mm. in diameter. A conical shade 102 mm. wide at base, 55 mm. wide at top, and 57 mm. high, having an opening 34 mm. wide, is placed around the flame. The light which serves as the ten candle standard passes through the opening in this shade. Levelling screws are provided, by which the lamp is adjusted until it is vertical, and the height of the steatite ring (when using the Table Photometer) is 353 mm. from the table."

The American lamps differ from the English in details, but not in essentials. They have a metal tube instead of an India rubber tube to convey the pentane vapor from the saturator to the burner,

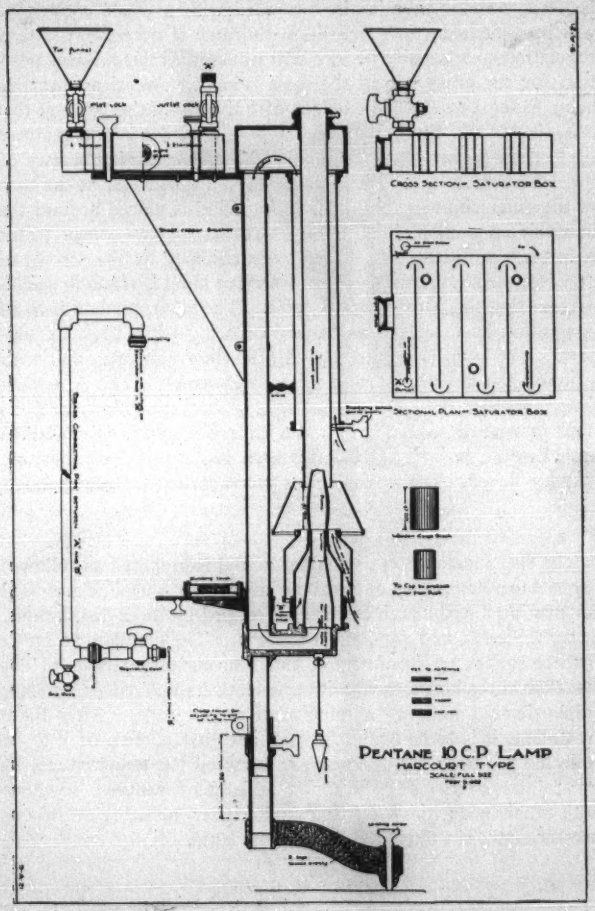


Fig. 3. Sectional view 10 c. p. Harcourt Pentane lamp, American make.

as it was found that the pentane had a solvent action on the rubber. The vapor tube is also provided with a waste cock from which condensed vapor may be withdrawn if necessary; with a regulating cock capable of nice adjustment. It has a lower position for the cross bar in the mica window, American practice being to regulate the flame height with the top of the flame at this cross bar, while English practice regulates at a position midway up to their higher cross bar. The chimney centering screws of the American lamp are threaded through a split collar at the base of the outer chimney, and a stiffening band is placed around the inner chimney upon which the ends of these screws touch. This is to prevent indentation of the inner chimney by the screws as they lengthen by heating. The American lamp is made in such a manner that the burner is removable. The saturator box is fixed in position by three screws instead of being loose upon its support. The lamp is provided with a leveling platform, and with a plumb-bob directly beneath the burner center. The American lamp is heavier, due to the use of light brass castings in some positions instead of sheet work. The dimensions of the two lamps are identical, however, and after each has reached equilibrium, they are in very close agreement as stated earlier in this paper.

FUEL.

The fuel supplied to this standard lamp is prepared as follows: Light American petroleum, such as is known as gasoline and used for making air gas, is to be further rectified by three distillations, at 55°C., 50°C. and 45°C. in succession. The distillate at 45°C. is to be shaken up from time to time, during two periods of not less than three hours each, with one-tenth its bulk of (1) strong sulphuric acid, and (2) a solution of caustic soda. After these treatments it is to be again distilled, and that portion of it to be collected for use which comes over between the temperatures of 25°C. and 40°C. It will consist chiefly of pentane, together with small quantities of lower and higher homologues whose presence does not affect the light of the lamp.

TESTING THE FUEL.

The density of the liquid pentane at 15°C. should not be less than 0.6235 nor more than 0.626 as compared with that of water

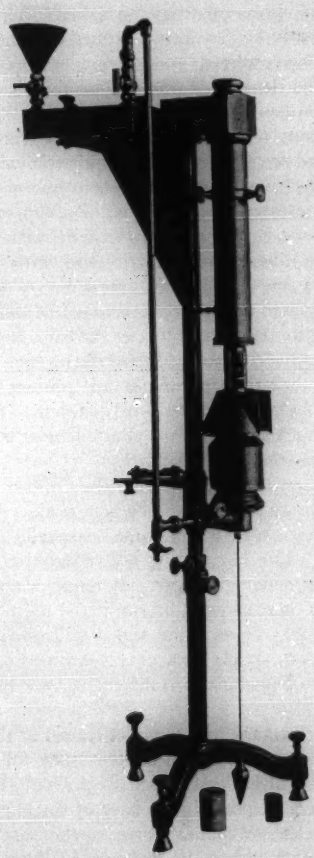


Fig. 4. American Pentane lamp.

of maximum density. The density of the pentane when gaseous, as compared with that of hydrogen at the same temperature and under the same pressure, may be taken. This is done most readily and exactly by Gay Lussac's method, under a pressure of about half an atmosphere, and at temperatures between 25°C. and 35°C. The density of gaseous pentane should lie between 36 and 38, hydrogen being taken as 1.

Any admixture with pentane, of hydrocarbons belonging to other groups and having a higher photometric value—such as benzene or amylene—must be avoided. Their presence may be detected by the following test: Bring into a white stoppered glass bottle of from 80 c.c. to 100 c.c. capacity, 10 c.cs. of nitric acid, spec. grav. 1.32 (made by diluting pure nitric acid with half its bulk of water). Add a few drops of a dilute solution of potassium permanganate, sufficient to give to the acid a full and permanent pink color. Pour into the bottle 50 c.cs. of the sample of pentane, and shake strongly from time to time during five minutes. If no hydrocarbons other than paraffines are present, the pink color, though somewhat paler, will still be distinct. If there is an admixture of as much as ½ per cent. of amylene or benzene, the color will have disappeared.

This fuel is very volatile, requiring the tightest of cans for storage, and the storage place should be kept cool. When burning in the lamp it gives a soft, white flame, especially adapted in color to gas testing. The lamp must not, of course, be filled while lighted, or when a flame is near. It requires about fifteen minutes to reach its thermal equilibrium, if the room be not too cold, when the flame may be adjusted and it will remain at a constant height. The room should be evenly ventilated to secure this result. One pint of pentane is sufficient for six hours burning at normal height.

While putting pentane into the inlet funnel of the saturator, the outlet cock and waste cock will be kept open for a vent, but the regulating cock will be kept closed to prevent the accumulation of vapor and its condensate in the base of the burner. After filling close all cocks. When lighting, open first the waste cock, then the outlet cock, when the pressure in the saturator will be released and any waste vapor or air in the vapor tube will be discharged below the burner level. Then open the inlet cock, close the waste cock, and holding a lighted match over the burner,

gradually turn on the vapor stream by means of the regulating cock. If any condensation has formed in the base of the burner, the first ignition will show a pointed blue flame playing lazily at the center of the burner. As the air supply increases this will turn to a greenish color and a small sharp explosion will result. The regulating cock will then be opened gradually until a proper ignition ensues, indicated by a steady, white, well-formed flame.

There cannot be two opinions by those who know, as to which of the working standards above described is best adapted for gas photometry of the accurate kind. In the Philadelphia Gas Works six pentane lamps are kept in constant use, and have completely demonstrated their reliability.

As some interest attaches to the uncertain relations existing between the primary standards of England, France and Germany, I give below a table of these ratios taken from a Bureau of Standards Bulletin prepared by Dr. E. P. Hyde (1907).

Summary of Ratios of Hefner, Harcourt (10 c. p.) and Carcel:

	Harcourt Hefner	Carcel Hefner	Harcourt Carcel
Reichsanstalt (using electric comparison lamp)	10.90	10.70	1.02
Laboratoire Central (using electric comparison lamp)	10.76	10.76	1.00
Laboratoire Central and Laboratoire d'Essais (direct comparison)	10.72	10.73	1.009
National Physical Laboratory (British)	10.95	10.69	1.024
Ratios computed from Bureau of Standards incandescent lamps	11.19	10.73	1.043
Best previous values (Bunte)	11.40	10.87	1.050

At the International Photometric Committee Meeting in Zurich, July, 1907, the following ratios were adopted, it being understood that the normal water vapor content for the Carcel and the Harcourt should be ten litres per 1000 litres of dry air and for the Hefner 8.8 litres per 1000.

Carcel = 10.75 Hefners
Harcourt = 10.95 Hefners } Probable error
Harcourt = 1.020 Carcels } ± 1 per cent.

A PROPOSED STANDARD HORSEPOWER RATING FOR AUTOMOBILES.

A standard for horsepower rating and alcohol-acetylene as a fuel was the subject taken up at the April meeting of the mechanical branch of the Association of Licensed Automobile Manufacturers. The need of a universal method for computing horsepower was discussed and suggestions for the adoption of an A. L. A. M. horsepower standard was recommended.

The horsepower of a car under the present ratings may mean anything a salesman may say, as various formulæ for computing these ratings are used, no two giving the same results. After having the advisability of a universal rating under consideration for several months the standards suggested by the branch were to be taken from a brake test at the flywheel, in conjunction with a formula to be suggested by the Test Committee. Two units were to be used, the lower being the actual rating from the brake tests, as computed from an indicator at 1000 ft. per minute piston speed, and the higher number to be the maximum horsepower developed from superior workmanship or the results of a better type motor. For example, in a 20-24-hp. motor the 20 would be the actual horsepower at 1000 ft. per minute piston speed and the 24 the horsepower which would be developed when not under normal conditions. The value of this is readily seen, as it would prevent salesmen or entrants in tests from rating a car at 30 hp. when it would actually develop 60, thereby not only misrepresenting the rating of the car, but taking an advantage of those giving an actual rating.

The discussion of alcohol-acetylene as a fuel developed some interesting matter. The growing need for a substitute for gasoline was realized, but whether acetylene and alcohol in combination would supplant the present fuel supply, is a problem yet unsolved. Mr. White, of Baker & White, exponents of the new fuel, gave a most interesting illustrated talk on the subject. Radical statements were made by him as to the efficiency of the carbide-alcohol mixture. Mr. White predicted that by September 1, alcohol could be obtained at a figure less that twenty cents per gallon, and that in certain places and in quantity carbide could be purchased for this purpose at one cent per pound. He has proved that to get the best results a half pound of carbide should be used to a gallon of alcohol, this making the cost of the new fuel slightly over twenty cents a gallon to the consumer. Every gallon of denatured alcohol contains about ten per cent. of water, which was found did not work as well as alcohol containing eighteen or twenty per cent. of water, the addition of this extra water increasing the combustion qualities of the mixture.

As engines are now built for the use of gasoline, it would be much more practical to adapt the fuel to the engine than the engine to the fuel. It seems, however, from experiments now under way, that in a short time gasoline will have one or two very strong competitors as fuel for automobile propulsion.

A business meeting of the branch followed the regular session and three new members were added to the Tire Committee to assist in the furtherance of the standardization of the tires it has adopted.—*Iron Age.*

An Eminent Inventor.

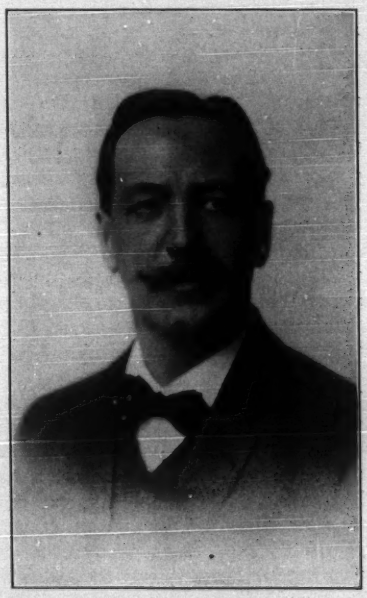
WHILE VISITING THE UNITED STATES GIVES VALUABLE INFORMATION AND SUGGESTIONS ON LIFEBOAT LOCATION AND THEIR HANDLING AT SEA.

Many of our readers have noticed that Mr. Axel Welin, of London, was present at the last annual meeting of the Naval Architects and Marine Engineers in this city, on which occasion he read a very interesting paper on one of his latest inventions, viz., "The Welin Quadrant Davit," and which paper created earnest, intelligent and friendly discussion.

Axel Welin was born in Stockholm, Sweden, about forty-five years ago, his father being private secretary to the late King Oscar of Sweden. When fourteen years old, however, he, together with several brothers and sisters, was suddenly left fatherless. After some years of hard study he passed the final examination in naval architecture and mechanical engineering at the Technical College at Stockholm. His splendid scholarship won him a position in that institution as teacher in draftsmanship. At the same time he held a position at the Palmcrantz & Nordenfeldts gun factory in Stockholm, where he made a name for himself by inventing ingenious tools for manufacturing lead bullets, shells, etc. Later on Mr. Welin was transferred to Maxim-Nordenfeldts gun factories in England, where he soon became one of its leading men. It was during those years that he invented the well known Welin breech screw for ordnance, which is now used either as originally invented or of the amended style in almost every gun from three-inch calibre up in most of the armies and navies of the world.

Later Mr. Welin severed his connection with this firm and started for himself. It was not long before he sold his various gun patents to Vickers & Maxim, in England, Krupp, in Germany, the United States Government, and others. Those who have any knowledge of the manufacture of guns are aware that he

received valuable consideration for his patents. In the meantime he invented several other useful articles of less importance, when Mrs. Welin, being of a philanthropic nature, expressed the desire that instead of inventing destructive machines her husband should utilize his brains for something to save lives. His brother being a sea captain, at that time in command of the Swedish steamship Hispania, for several years chartered by the United Fruit



AXEL WELIN, A. I. N. E.

Company and trading to the West Indies, drew his attention to the general unsatisfactory appliances that had so far been used for launching lifeboats on board ships.

Mr. Welin made several trips to sea, acquainting himself with the various conditions and also collecting some important data of a number of shipwrecks where lives had been lost by the hundred.

In most of these cases he found that although the lifeboats were well constructed and seaworthy, the great loss of life was in most cases caused by the difficulty of launching them on account of the operation requiring too much time and a large number of skilled seamen. In other words, in about every such accident it was the same old story—the crew could not launch the lifeboats in consequence of the rolling of the ship during which they lost control of the boats, which were immediately stove in; besides, they could only launch the boats on one side when the ship oftener than otherwise had taken a list, and not infrequently they could not launch the boats at all because the passengers, in their excitement and hurry, had filled the boats while the same rested on the chocks, consequently valuable time was lost in getting them out of the boats so that they might be launched. In the meantime the ship goes down with boats, safety appliances, passengers and crew.

Taking these dangers and their causes into consideration, Mr. Welin set to work to devise an apparatus that would meet all the requirements with the least possible complications and manipulations. His final solution of the problem is demonstrated by his invention of the Welin quadrant davit, which it can safely be said is the only patented davit that has been generally adopted by ship owners, and approved by the Board of Supervising Inspectors of Steam Vessels; and this in the short time of less than two years.

Before Mr. Welin left New York for Europe, recently, he made a tour of the United States as far as San Francisco, giving addresses at various places before such institutions as the Franklin Institute in Philadelphia, the Engineering Society in Detroit, Stanford University and the Technical Society of the Pacific Coast in San Francisco. These addresses, which were illustrated by some sixty stereopticon slides, were emphatically pronounced scientific, instructive and interesting. We hereby quote two or three items from the same, one from the superintendent of the Royal Mail Steam Packet Company, who says:

"You may run your line of steamers for fifty years without an accident, and then all of a sudden you lose one or two, perhaps more, ships in succession, and which disasters are combined with great loss of life. Then it will not help your case if you draw the public's and the authorities' attention to the fact that you can show them that you have made use of every improvement avail-

able in order to safeguard your passengers from loss of life, that argument will go a long way."

In his paper to appear next mnoth, Mr. Welin discusses the great advantage of being able to quickly swing the boats out on the high side and continues: "A further and convincing example of what may be accomplished in this direction reached me only last week in a report received from one of the foremost shipbuilding firms on the Clyde: 'Your davits on the port side had a big test the other evening. It appears that this steamer took a dangerous list. owing to the coals shifting in the starboard bunkers and to right her the boats were quickly swung out on the port side and filled with water. This had the desired effect.'" The vessel referred to is about 5,500 tons gross and is fitted with five 28-foot lifeboats on each side, and when filled with water represented a weight of seventy tons. This prompt action saved the ship from capsizing, as several others have done under similar conditions recently. The boat decks of this ship were of very light construction, and it was a surprise to the builders that in undergoing this operation they did not show any sign of weakness.

Mr. Welin has been more fortunate in disposing of his inventions than many other inventors, inasmuch as he has been able to obtain valuable consideration for his many ingenious creations, among which is the Welin quadrant davit, the patent for which he has sold to the Welin Quadrant Davit Company of New York City. The world will surely hear more of the inventions of Mr. Welin in the near future, as he is a comparatively young man, and always studying to improve that which is unwieldly and impracticable in mechanics.

As a further example of his advanced ideas we hereby reproduce a suggestion of this eminent inventor where he proposes to place the lifeboats nearer the water on the gigantic high-sided Liners now being built. Every naval architect and engineer as well as sailor can readily see the advantage of such a proposition. Take, for instance, a big steamship where the staterooms are located on from four to six different decks, the passengers on the lowest decks would consume valuable time before they could reach the lofty boat deck were it necessary to abandon the ship. One can imagine what it would mean to lower one of the boats from a deck sixty feet from the sea when it would be necessary to pay out 360 feet of rope from each davit. As proposed by Mr. Welin, the

boats would be centrally located for passengers on the upper and lower, and more convenient to those on the two intermediate decks, thereby adding to the safety of all in case boat service became necessary. Next to the value of the quadrant davit is this change in the location of the boats suggested by Mr. Welin, and we predict its early suggestion by owners and adoption by builders of new ships. The stability and buoyancy to be gained in favor of the vessel by placing these davits and enormous weight of boats so much nearer the water line would be great, besides leaving the upper decks clear of boats and gear for the benefit of the ship's passengers whose natural desire is to get as far away from the water as possible.

THE PRODUCTION OF ARSENIC AS A BY-PRODUCT IN SULPHURIC ACID MANUFACTURE.

By Edward Walker.

Until recently the arsenic removed from sulphuric acid has been wasted, owing to its production in the form of sulphide, which is not a commercial commodity. During the last year or two the United Alkali Company has conducted experiments with a new process by means of which the arsenic is recovered as arsenious acid. The process promises to be a commercial success, and in all probability will bring an important new supply of arsenic on the market, as well as make it possible to use highly arsenical ores profitably in sulphuric acid manufacture.

The process is described in a series of British patent specifications, the most important of which is No. 5151 of 1906. That the process is a success is shown by the fact that five plants are already in operation, and that arrangements are being made for building several more.

According to this process, the arsenical sulphuric acid, as it flows from the Glover tower, is first brought into contact with a reduction agent such as charcoal, in order to bring the arsenic to the arsenious state. It is then brought into contact with dry hydrochloric acid gas, the result being that the arsenic is converted into liquid arsenious chloride. This chloride is an oily liquid and a good deal of it can be separated from the sulphuric acid by settlement. The sulphuric acid drawn off from the settling tank still contains arsenious chloride. To remove the latter, air is blown through the acid. The chloride comes off as vapor, and is taken to a scrubbing tower. Here it comes in contact with water, with the result that arsenious acid and hydrochloric acid are formed. The hydrochloric acid is used over again, and the arsenious acid is collected as a commercial product. Very often, however, the arsenic contains selenium. If so, some of the arsenious chloride, which had previously separated as an oily liquid is

added to re-dissolve the whole of the precipitated oxide, and then, on addition of water, the selenium is found to be precipitated.

The process is naturally one which requires very careful attention, owing to the existence of arsenic as a volatile compound. The manufacturers and the alkali inspectors, however, speak well of the process, so it should develop into a standard method of recovering arsenic.—*Eng. and Min. Jour.*

WASTE OF ARTESIAN WATERS.

Millions of gallons of artesian waters are going to waste every day in Indiana, according to estimates made by F. G. Clapp, geologist of the United States Geological Survey, who is now investigating the water resources of the northern part of that State. Over a million gallons a day are wasted in a single county. Along Fall Creek, Lick Creek, White Run, and other streams, in the shallow valleys of which there are a great many flowing gas wells, each well pours out from five to twenty gallons of water a minute, and the amount of water thus drawn from the underground reservoirs and unutilized in Madison County alone is sufficient to supply a city of 10,000 inhabitants.

In only a few places is this water put to use. The farmers do not seem to realize that a hydraulic ram or a windmill placed on a flowing well will raise a large portion of the water to their houses on the hills above. Immense volumes of good water are therefore suffered to waste, and in this way the "head," or height of water in the wells, or the height to which it rises above the surface, has been lowered several feet. Many wells that once yielded copious and strong flows have ceased to flow entirely. By this means, also, the ground water-level in this region in ten years has been lowered over ten feet.

This loss of head, not only in Indiana, but in other parts of the country, has served to call attention to the fact that the available artesian supplies are by no means inexhaustible. Our "inexhaustible" supplies of natural gas and petroleum are rapidly being depleted, and the geologists and coal experts of the National Survey have computed with probable accuracy the date of exhaustion of our coal beds. Our "inexhaustible" forests are so dangerously threatened with speedy exhaustion that national legislation is now deemed necessary to protect them. The effect of deforestation on stream flow is at last well recognized. Since the forests of Indiana have been cut off the ordinary flow of many of the streams of the State has notably dwindled and the forest flow is far more destructive.

The conservation of the artesian water supply should not be very difficult. By simply capping unused wells, or by providing them with such means of stopping and controlling their flow, as is now applied to ordinary municipal supplies, the head of the wells can be preserved and the height of the ground water maintained somewhat near its old level. Legislation may be required to accomplish this result, yet some of the students of the matter, and among them are geologists of the Survey, hope that an intelligent understanding of the conditions will lead to practical means to check this enormous waste and its consequent immense losses in values.

Section of Physics and Chemistry.

Further Notes on Shellac. *

By Dr. H. Endemann.

In my first paper, which appeared in this *Journal's* October number, I have stated that shellac, after hydration, produces oily acids and one crystallizable acid, which I have announced to be a trioxypalmitic acid of unknown constitution at that time.

Farner states that on oxidation by permanganate in alkaline solution, azealaic acid and butyric acid are produced; this, however, I could not verify. Neither azealaic nor butyric acid is formed unless the acid is not pure but still contains some of the oily acids.

The oxidation is performed in a very dilute, strongly alkaline solution cooled by ice, to which an equal volume of permanganate solution likewise cooled by ice is added, with enough ice to keep the solution ice cold for several (2) hours. The quantity of permanganate is taken so as to represent three available atoms of oxygen for one molecule of trioxypalmitic acid; an excess of oxygen is generally taken, but this is finally removed after about six hours by the addition of bisulphite of soda. This insures the absence of trioxypalmitic acid which facilitates the final purification of the products of oxidation.

When pure acid is used for this experiment neither butyric nor azelaic acid is formed. Instead there are formed sebacic acid and δ oxycaproic acid.

It is practically impossible to separate these acids by crystallization from water, nor can the oxycaproic acid be washed out by fractional extraction with ether.

*See this *Journal*, October, 1907, page 285.

Using the barium salts a separation can be effected.

Any unchanged trioxypalmitic acid forms a very difficultly soluble barium salt, and can thus be removed. The barium salts of the two other acids are far more soluble. Their solution is brought to dryness, powdered as thoroughly as possible, and then treated with alcohol of 95%. This dissolves the barium salt of the δ oxycaproic acid, while the salt of sebacic acid remains insoluble. The latter can be purified by heating the solution, when the sebacic salt is precipitated and can be filtered off and freed from the mother liquor by pressing.

The barium salt of the oxycaproic acid is absolutely amorphous when dried. On analysis 0.3879 gave 0.2256 barium sulphate = 0.1328 Ba = 34.29% Barium (theory 34.4) equivalent calculated therefrom = 132.5 (theory 132). A water solution of the barium salt produces a jelly with silver nitrate solution; this jelly becomes crystalline (tufts of needles) after the removal of the mother liquor. The free acid produced from this forms an anhydride on evaporation, which, however, can again be converted into the acid by boiling with baryta solution.

The sebacic acid was found to melt at 132-133°C. and crystallizes in needles. The baryta salt of sebacic acid 0.1673 gave 0.1157 Ba SO_4 = 0.0681 Ba = 40.70 Ba% theory—40.72%.

ULTIMATE ANALYSES.

			Calculated
1. *Anhydride (Lacton) δ Caproic Acid:*			
	0.143 gave.....	0.330 CO_2 = 62.93 C	63.16
		0.1149 H_2O = 8.98 H	8.77
2. *Sebacic Acid:*		Calculated 59.41 C	8.92 H
	0.1592 gave.....	0.3466 CO_2 = 59.34 C	
		and 0.1211 H_2O = 8.45 H	
	0.1533 gave.....	0.3341 CO_2 = 59.43 C	
		0.1237 H_2O = 8.94 H	
	Next analysis	59.31 C	
		8.95 H	

The formula of this trioxypalmitic acid is therefore best represented as

$$CO_2H\ (CH_2)_8CHOH.\ CH.OH(CH_2)_3\ CH.OH\ CH_3$$

which forms sebacic acid and δ oxycaproic acid

$$CO_2H(CH_2)_8CO_2H + CO_2H\ (CH_2)_3\ CH.OH.CH_3.$$

In connection with the determination of the Iodine No. or Bro-

mine number of Rosin or Colophony I have determined the Bromine No. of Abietic acid. I found that Abietic acid, $C_{19}H_{28}O_2$, requires in tolerably concentrated chloroform solution about 18 atoms of bromine, forming a body containing 57.77 bromine, and being devoid of any acid properties; from which it is evident, that the action is accompanied by a loss of CO_2. The reaction pasess off with a copious volume of H. Br. escaping. I could not test Pimaric acid, $C_{20}H_{30}O_2$, for the reason that American colophony (in distinction from many European resins) contains but little of this. Pimaric acid, as has been known for fifty years, differs from Abietic acid, and can be distilled readily, even without vacuum.

As regards my own method of analysis, I have made some changes. In the first place I find that much less sand is required than I have stated, provided the sand is very fine; 3-4 grms. are ample.

For the determination of the non-condensable rosin and oil, independent of the water soluble salts and organic matter, it is desirable to moisten the residue in the dish with some hydrochloric acid before it is extracted by alcohol. Also the residue containing non-condensable rosin is not extracted with water only but water acidified by H Cl.

From a pamphlet published by George A. Alden & Co., it appears that in the manufacture of Seedlac from Sticklack, which contains the twigs upon which the insect has grown, as well as fragments of the insects, the sticks and much color are removed after coarsely grinding and sifting, by means of flushing and washing with water and treading with the bare feet.

The lac dye, which goes into water solution, is not recovered at present owing to the advent of the cheaper coal tar colors.

The remaining Seedlac either goes into commerce and is imported into the United States as such, or it undergoes further purification by a kind of filtration and is then sold as shellac.

The Seedlacs, which reach this country and of which a series were examined, are not always pure Seedlac, but in several cases showed adulteration by rosin.*

*Samples examined were marked respectively Taitwah, Hydrabad, Ragoon, Manbazare, Assam, Teelhar and Koosmi; also sample Koosmi prepared from Sticklac in laboratory.

In the manufacture of shellac the Seedlacs are dried and then filled into pipe-shaped cotton bags, heated over a fire and the pure shellac pressed out by twisting and then spread to cool in thin layers.

In this process chiefly inorganic impurities, parts of insects and woody fibre are removed. They remain in the bag, are collected and form the so-called refuse shellac. The composition of this refuse showed that it is still quite valuable. It arrives here in cakes of a reddish brown color.

According to my investigation, it contains still about 70% of alcohol soluble matter, and about 1% of resinous material, removable only by carbonate of soda treatment. The 29% remaining consists mainly of organized debris of insects and plants. They yield 4.8% ashes, mostly lime, soluble in acid, and 24.2% organic matter, also to a considerable extent soluble in H Cl.

From this it is evident that Seedlac, which contains still the refuse lac, yields more matter soluble in acid, but also more resinous oil. So, for instance, there was found in

	Non-condensible Resinous Oil.	Water and Acid Soluble.
Teelhar Seedlac	10.55	5.80
" "	10.63	—
Koosmi Seedlac made from Sticklac in laboratory	9.64	4.35
" "	9.24	—

If rosin is added to the Seedlac, when adulteration is aimed at, then the refuse lac, of course, also contains pine rosin.

The proper way to analyze refuse lac is simply to determine the alcohol soluble portion and treat this with sand and hydrochloric acid in the manner prescribed for shellac, taking heed of the absence of the wax in the alcoholic extract. Pressed out pure shellac contains but little of these impurities, generally only about 15% of the non-condensable substances.

D. C. shellac contains, according to my examination:

	Total	Organic Oils and Resins	Salts
	7.48	6.48	1.00
Prepared from D.C. sticklack in laboratory	7.22		

My figure allowing 8% is based upon these examinations, and gives to the manufacturer a leeway of a fraction of one per cent., which I now consider ample. I examined a series of V S O samples of shellac, partly reported to be free from rosin, partly believed to be so, for non-condensable resins and oils.

By my method the following figures were obtained:

Year of Delivery	Non-condensible Resinous Portion
1903	9.98
1904	9.24
1905	8.55
1906	8.30
1907	12.64

from which it is evident that they contained colophony in quantity from 3-6%. My qualitative test showed the rosin plainly in all of them. In order to ascertain the nature of the oily acids I have dehydrated the shellac by heat only, then extracted the foreign alcohol soluble matter by alcohol. The residual shellac is then hydrated again by means of soda.

This part of my work will consume some time but will be reported later.

New York, Dec. 9th, 1907.

DIAMONDS IN PLACE IN THE UNITED STATES.

Although diamonds have been found in at least thirty places in the United States, the only locality where they occur in place has recently been discovered and has been investigated by Mr. George F. Kunz, the gem expert, and Dr. H. S. Washington, petrographer. They occur in an igneous rock, similar to that of the South African mines, which forms a small stock near Murfreesboro, Pike County, Ark. The first two stones were found August 1, 1906, and since then many of them have been picked up, the total number found at last report being 130. Many of them are white and of good water others are yellow, and some are of brown bort. The two largest stones weigh 6½ carats, one being exceedingly fine white and the other brown. They are found on the surface as well as within the greenish, friable, decomposed peridotite, a rock somewhat like the famous "blue ground" of Kimberly. The property is being actively prospected and developed.

BROWN IRON ORES OF ALABAMA.

As a producer of brown ores Alabama ranks first among the iron-producing States. In 1905 there were 781,961 long tons of brown ore mined in Alabama, and over 36 per cent. of this was produced in the Russellville district. This district situated in Franklin County, in the northwestern part of the State, comprises an area of about twenty-five square miles, within a rectangle eight miles from east to west by about three miles from north to south, with Russellville near the middle of the northern edge. The Northern Alabama Railroad crosses the area from north to south, connecting the ore mines and limestone quarries near Russellville with the blast furnaces near Sheffield. It is a matter of historical interest that probably the first furnace erected in Alabama was built in this district in 1818, on the north bank of Cedar Creek, where surface ore fed to a primitive charcoal furnace was made into cast and malleable iron. The furnace was probably abandoned about 1827. Sixty years later iron-making was revived in this region, but in a better location in respect to water supply and transportation routes.

The iron ores of the Russellville district occur in irregular masses, bowlders, pebbles and sand, and as cementing material in beds of conglomerate. They are dark brown in color and have generally been termed limonite. These ores are the subject of a brief paper prepared by Mr. Ernest F. Burchard, of the United States Geological Survey, and published by that bureau in Bulletin No. 315 (Contributions to Economic Geology, 1906). That this report is particularly timely is shown by the fact that, although considerable areas of proved lands still await development in the Russellville district, land owners and persons concerned in the iron trade display an ever-increasing interest in the possible distribution of brown ores in other parts of the region. As similar geologic conditions exist throughout the northern part of Franklin County and the southern and western parts of Colbert County, Alabama, the eastern part of Tishomingo County, Mississippi, and parts of the Tennessee Valley in Tennessee and Kentucky, deposits of brown ore resembling those of Russellville may be discovered in the localities mentioned. Attention is called to the fact that as surface prospects are not invariable indication of the extent or value of the ore beds below, there may be local segregations of ore many acres in extent that do not appear at all at the surface. It is suggested that information of such occurrences may be obtained by small test wells, three or four feet in diameter and twenty to fifty feet deep, which may easily be sunk in the loose loam and gravel. The main fact to be borne in mind is that localities worth prospecting for brown ores are underlain by limestone beds which are surfaced with 20 to 100 feet of loam and gravel.

Bulletin No. 315 may be obtained by applying to the Director of the United States Geological Survey, Washington, D. C.

Section of Photography and Microscopy.

(Stated meeting held Thursday, January 30th, 1908.)

Teachings and Practice of the Lumiere Starch Grain Process.

By J. E. Brulatour.

THE PRINCIPLE OF THE PROCESS.

If on the surface of a sheet of glass, and in the form of a single film, a collection of microscopic elements, transparent, and colored reddish orange, green, and violet are spread, we shall find, if the spectral absorption of these elements is correct, and if they are *in correct* proportions, that the film thus obtained, when examined by transmitted light, will not appear colored; this film will only absorb a fraction of the transmitted light.

The luminous rays traversing the fundamental screens, orange, green, and violet, are reconstructed, and from white light if the sum of their surfaces for each color, and the intensity of the coloration of the constituent elements exist in proper proportions. The thin trichromatic film thus formed is subsequently coated with a panchromatic emulsion.

If now such a plate be submitted to the action of a colored image, taking the precaution to expose it through the back, the light rays traversing the fundamental screens, will, according to their color and the color of the screens they encounter, suffer a variable absorption. Thus we realize a selection by the microscopic elements which enables us, after development and fixation, to obtain colored images; the colors being complementary to those of the original.

HOW THE COMPLEMENTARY (NEGATIVE) IMAGE IS FORMED.

If we take, for example, a part of the image colored red, the red rays will be absorbed by the green elements of the film, whilst the violet and orange elements will transmit them. The panchromatic film, therefore, will be acted upon under the orange and violet elements, and the green elements will appear, after the fixation, because the panchromatic film has not been acted upon under the green elements.

Development will reduce the silver bromide of the films and

mask the orange and violet elements, and the green elements will appear, because the silver bromide has not been reduced under them. We have, then, in this case, a residue colored green, which is complementary to the red rays we have been considering. The same phenomena will occur with the other color; that is to say, with green light, green elements will be masked, and the film appear red. In the case of yellow, the violet image will appear, and so on. It will be seen that a negative in these complementary colors ought to give, with a plate prepared in the same way, positives which would be complementary to the negative; that is to say, positives which would produce the colors of the original.

One might also, after development of the negative image, omit the fixation, and reverse the image by one of the well-known methods so as to obtain a positive direct, which would present all of the colors of the original object.

The difficulties which we have encountered in the application of this method are numerous and considerable; but, after laborious researches we have surmounted them, and the Lumiere Company is prepared to supply such plates.

It will be sufficient to briefly indicate some of the most important conditions which had to be fulfilled to prove how delicate the problem was.

TECHNICAL PROBLEMS OF THE PROCESS.

We have first to find the film formed of microscopic filters, orange, green, and violet. It was necessary that this film should adhere to its support, be very thin, and that the coloration of the elements of which it would be composed should be rigidly determined as regards intensity and exactness of color, and as regards the number of elements to a given area. The colors must be stable, they must not run, and there must be no superposition of the colored filters, and no interspaces. Finally, the film has to be covered with varnish having the same index of refraction as the grains.

It was essential that the sensitive film should be orthochromatized—so that there should be no false rendering of colors—and that this orthochromatizm should be in a relation to the nature of the emulsion and the color of the elementary filters. The film of the emulsion should be of a special nature to prevent

diffusion, and the manipulations, development and exposure should be appropriate to these preparations.

The simple enumeration of one of the conditions will serve to show how much care and method is necessary. First, potato starch had to be separated by instruments specially devised for the work, for the grains have a diameter of from 15 to 20 thousandths of a millimetre. These grains were divided into three lots, which were respectively stained reddish-orange, green, and violet, by the aid of special coloring matters.

The colored powders thus obtained were mixed, after complete desiccation, in such proportions that the mixture did not show any residual color. The resultant powder was then brushed on to a sheet of glass, covered with a sticky substratum. With suitable precautions, we shall obtain a single film of grains, which touch each other without any superposition.

The interspaces had to be filled by a similar process of powdering so that no white light was transmitted. This obscuration is effected by means of an extremely fine, black powder of wood charcoal, for example.

We have thus formed a screen on every square millimetre of surface, of which there are eight to nine thousand of small elementary screens, orange, green, and violet. The surface thus prepared is protected by a varnish having about the same refractive index as that of the starch grains, a varnish as impermeable as possible, on which finally a thin film of sensitive panchromatic emulsion of silver bromide is coated.

The exposure is made in the ordinary way in any camera, but in every case taking the precaution to reverse the plate so that the rays from the lens traverse first the colored particles before reaching the sensitive film. It is also necessary to interpose a special yellow screen to compensate for the excessive activity of the violet and blue rays. The absorption due to the interposition of the colored elements, although a very sensitive emulsion is used, necessitates a somewhat longer exposure than usual. Still, it is possible to obtain results in sunshine in one-fifth of a second, with a lens working at f/3.

Development is effected as in an ordinary photograph, and if one is content to fix the image, the result will be, as we have already pointed out, a negative presenting by transmitted light the colors complementary to those of the object photographed. But

it is preferable to re-establish the order of the colors, on the same plate, by chemical reversal of the image. For this, the silver reduced by the developer is dissolved by a suitable bath, and then the remaining silver bromide is developed, producing a black image, which is complementary to the negative obtained by the first development.

It will thus be seen that the manipulations are simple and only slightly different from those of ordinary photography.

PETROLEUM IN ITALY.

As early as 1893 a French company obtained a concession from the Italian Government to explore a certain tract in the Apennines, near Piacenza, and to export any deposits of petroleum found there. The success of this company was sufficient to cause the formation of another French syndicate four years ago, and last July these two were absorbed by a Genoese company, with a capital of $3,000,000. The wells already bored are some 95 in number, of which 70 are practically exhausted. The remaining 25 produced about 40,000 barrels of crude oil in 1905, and with the eight wells now boring it is expected that the total production for 1906 will have reached over 65,000 barrels. The concession of the new company comprises about 11,000 acres.

The wells, none of which are gushers, reach a minimum depth of 1300 feet and the engineers in charge say that those which are exhausted may be made to yield again by deepening. This has not as yet been undertaken, perhaps because by the terms of the grant it is necessary to bore new wells in order to maintain control of the territory. A central motor is used to operate, by cables, the pumps of the various wells.—*Eng. and Min. Jour.*

OLD AGE PENSIONS for workingmen will be made the chief object of the labor members of the British Parliament at the present session. The Parliamentary Committee of the Trades Union Congress, in its public manifesto urging this legislation, says that commissions and committees have sat long enough and that the time has come for action. It states that "half a million of old people over sixty-five years of age are dependent upon charity or Bumbledom for the ordinary necessaries of life; the pressure of workshop life is such that old people find increasing difficulty in getting employment, and the workhouse is, in too many instances, the only refuge after a life of labor." It is added that about 200,000 persons are now in receipt of over £9,000,000 a year in pensions from the exchequer, most of whom were well paid in the public service. The plea is that the "soldier of labor" be now put on the list.—*Iron Age.*

Mining and Metallurgical Section.

Recent Advances in the Metallurgy of Zinc.

By Woolsey McA. Johnson.

For a proper and precise understanding of the changes and improvements in the treatment of zinc-bearing ores, attention must be given to the peculiarities of the reduction of zinc oxide to the metal.

The temperature at which zinc oxide begins to be reduced by carbon varies with the physical nature of both oxide and carbon but has been shown to lie between 1020°C. and 1100°C.* The boiling point of zinc at atmospheric pressure is 920°C. Consequently we have zinc vapor formed when zinc oxide is reduced.

The further fact that zinc vapor is oxidized with avidity with weak oxidizers as water-vapor and carbon dioxide necessitates the use of a large excess of fixed carbon, so that the gas of reduction is practically speaking carbon monoxide.

We therefore see that indirect heating of the roasted ore and coal is a *sine qua non* in the reduction of zinc ores.

Also it can be stated that this zinc vapor is condensed into metal under conditions but imperfectly understood by the average zinc metallurgist and always in small condensers.

Finally, from these theoretical conditions we have the resulting practical conditions that zinc ores are roasted to a dead roast, mixed with fine non-caking carbonaceous material and charged into small fire-clay retorts, holding from 50 to 80 pounds

*Woolsey McA. Johnson, "Thermo-Electric Determinations of the Reduction Temperature of Zinc Oxide." Trans. American Electrochemical Society, April, 1904.

of ore, heated by a gas flame, the volatile products passing into condensers where the metallic vapor is condensed.

The commercial conditions are that from 2¼ to 3½ "men-days" and from 2½ to 3½ tons of coal, or its equivalent in natural gas, are needed to treat one ton of zinc concentrates at the reduction plant; that the cost of treatment in America is usually from $10.00 to $14.00 per ton of ore (running as high as $17.00 in one plant); that 140 lbs. to 170 lbs. of zinc per ton of concentrates are lost in treatment.

Naturally, the tendency is to locate plants at points in coal fields or in natural gas fields. As the fuel needed is in excess of the ore, the ore is always brought to the fuel field.

In the United States, the peculiarities favoring the development of the zinc business almost seem to have been given by Providence. Let us take the great mining district called the "Joplin field" and the Missouri and Kansas smelting plants. In the first place the ores at Joplin require only simple water-concentration in order to produce a concentrate averaging over 58% zinc. The mines are near the surface and require the simplest facilities. Only a few miles distant from this field are coal fields which produce a large tonnage of slack suitable for use in the Belgian type of zinc furnace.

Hence, this development did not need great amounts of capital. Furthermore, the treatment of the pure concentrates was easy provided the condensers were enlarged because no fluxing mineral impurities were present to prevent hard firing. A supply of native labor was at hand which in a decade became expert at the furnace labor. Finally, a set of resourceful entrepreneurs, who though not metallurgists were hard-headed business men, took up the zinc business. In addition, the clay of the clay beds near St. Louis are extremely suitable for retort making.

We thus find that from 1880 to 1896, the business of the Missouri-Kansas zinc miners and smelters grew fast and flourished with our country's industrial growth.

In 1898, labor became scarce and dear, and by great fortune, at about the same time the "Iola" gas field was found and the "Iola" type of natural-gas fired zinc furnace was devised by hard work in the zinc fraternity, where the work of the furnace was so systematized that the labor-charge was diminished. And over

60% of the spelter is to-day made in the "Kansas-Indian Territory" zinc smelters, using gas as fuel.

Further analysis would show the reasons for existence of the zinc smelters in Illinois, with their by-product acid plant, and the zinc plants in the anthracite field drawing their ore from the great Franklin mine of the New Jersey Zinc Company. But this short sketch of the business is to impress the fact that the conditions for zinc smelting are unique, because of the large amount of fuel used and the high labor-charge per ton of ore, and the required absence of fluxing impurities in the ore.

Consequently, zinc ores are mined and concentrated so as to ship to the American smelter plant a product that when roasted will analyze at least 38% zinc. The Joplin ores "roast" to 70% zinc. Previous to 1903, little ore was used in the Western spelter plants that averaged under 65% zinc roasted.

The progress in the treatment of zinc ores has been in two directions, the bettering of the concentration methods producing from complex sulfides a higher grade concentrate, and in the treatment of the "ore" in the spelter plant.

It is peculiar that the art of concentration of complex zinc ores has improved so as to make a concentrate higher in zinc and that the art of reducing zinc "ores" to spelter has improved so that a "concentrate" or "ore" lower in zinc could be treated in the retort. This metallurgical compromise has had the effect of increasing the spelter production from ores other than Joplin. Whereas five years ago the Western zinc smelters treated only Joplin concentrates, to-day the tonnage of ore from Mexico, Colorado, New Mexico and Wisconsin sent to the Illinois and Kansas smelting centers approximate the production of the Joplin field.

Joplin, however, is still preëminent in its influence on the metal markets for the reason that over 60% of the metal produced in the United States comes from ore hoisted from shafts in the prairies of Jasper County.

Joplin concentrates make nearly double the tonnage that "Western" or Mexican stuff does, and as a company's hold on the metal markets depends on tonnage, in times of great demand for metal it is better to run on Joplin ore. In times, when the "margin" for the spelter plant is small, as just now, (in other words, when metal is sold at "auction-room" prices), the margin on low-grade "Western" ores is larger and capital invested in ore stocks

smaller, and difficulty of selling restricted tonnage of metal is lessened. These are the main commercial principles governing the treatment of low-grade concentrates.

The advance in the treatment of zinc ores of the Rocky Mountains by "ore-dressing" has been due to the pressure on the "West" for ore, due to the fact that Joplin could not increase its production apace with the enormous demand for ore.

In my opinion, the chief reason for the improvement, the germ as we might call it, was the "Blake-Morscher" electro-static machine. I am aware that this machine is not the great practical success that was predicted, but still it stimulated work in the treatment of complex ores of the "West."

Parenthetically it may be remarked that in the zinc business the "West," as a term. applies to the country of the "Rockies," as distinguished from the Joplin field.

The Blake-Morscher machine depends on the fact that metallic sulfides with a metallic lustre conduct electricity, while zinc sulfide and the gangue minerals, as quartz, barytes, calcite, etc., do not. Accordingly when a mineral product containing iron pyrites and blende is dropped on a charged roller the iron pyrites assume the same charge as the roller and is repelled (sometimes thrown with violence five or six feet), while zinc blende slides down in so short a time that it is not repelled. Consequently a separation is made between the zinc sulfide and iron sulfides of the "zinc-iron middlings" of the "Wilfley" table. Profs. Blake and Morscher, of the University of Kansas, made the first practical application of this, while Mr. W. G. Swart, of Denver, by hard work, has helped in evolving the machine to commercial success. A complete account of it is given in the Report of Mr. W. R. Ingalls, relative to the zinc resources of British Columbia to the Dominion Government, pages 118-121.

The Blake machine has not been much of a success as yet in other than dry climates. For instance, it succeeded in the mill of the Colorado Zinc Company, at Denver. But as yet has made no large success elsewhere.

The Sutton-Steel²-Sutton machine has been developed in El Paso, Texas. It works on the same general principles as the Blake. But as yet has made no demonstrated practical success. As it is developed in a mining center, it has the benefit of direct practical contact with the needs of the mines.

The so-called "Huff-Dolbear" machine has been developed in Boston. It has had the benefit of the advice of such authorities as Prof. R. H. Richards in the "ore-dressing" line, and Prof. Elihu Thompson, of the General Electric Company, in the electrical end of it. Seven years ago, when I was a student at Harvard, I saw one of their experimental machines. Just lately, a strong zinc mining and smelting company have taken hold of the commercial exploitation of the machine. So long is the period of gestation of a radically new process.

The great trouble with these electrostatic machines is the lack of proper knowledge of the scientific conditions of the problem. This is to be expected, as electrostatics is a part of electrical science that has not had much practical application. In the future, as a better understanding of the question is attained, a greater degree of success can be reached. My practical friends may laugh, but my opinion is that hard and close study of the philosophy of the subject is a *sine qua non* for success.

Of far great actual importance, in the way of financial returns, is the Wetherill magnetic separator. This has had its great success at the works of the New Jersey Zinc Company at Franklin Furnace, N. J. The ore of the Franklin mine analyzes roughly 20% zinc. The zinc is present chiefly as willemite, the anhydrous silicate of zinc and the magnetic franklinite, a complex of iron oxide, manganese oxide, and zinc oxide. The ore is subjected first to a preliminary water concentration to remove the gangue. The heads, containing willemite and franklinite, are dried and passed over the belts of the Wetherill machines. Here magnets of high intensity lift up the magnetic franklinite and leave the non-magnetic willemite. The "willemite-product" analyzing 47% zinc is sent to the spelter plant and the franklinite analyzing 22-26% zinc is mixed with coal and "blown-up" to zinc oxide in the "oxide" furnaces, which is later caught in a "bag-house" and sold as a most excellent pigment—"zinc white." The residue or clinker from this operation is smelted in short iron blast furnaces to produce iron-manganese, or "spiegel-eisen." The "spiegel-oxide" caught in hot blast stoves and flues of the blast furnace and the "refuse-oxide" from the flues of the oxide plant is a most excellent material to charge into the spelter retort. Due to the fact that the grade of the ore is so high (four or five times that of the Joplin field), and to the fact that the price of products is high by

reason of their unequalled purity, the operation is most profitable. Because of the neatness of the chain of related metallurgical operations, the recovery of metalliferous products from the ore is the highest of any zinc company in the world.

In the "West," the Wetherill machine has had a peculiar use. Zinc blende contains usually varying percentages of combined iron. As this percentage increases, the product becomes slightly magnetic.

The so-called "marmatite," or zinc-iron mono-sulfide, contains some 10% "combined iron." The large dumps of "middlings" of the lead mills of Colorado were composed partly of "marmatite." These were dried and passed over Wetherills and a product analyzing from 42% to 46% zinc produced. By 1903, certain of managers of the zinc plants learned how to treat such a product. The Colorado Zinc Company treats these ores and middlings by a complicated process. The stuff as it came to the mill was tabled and three products made: (1) a lead product for the lead plant; (2) silicous tailings; (3) zinc iron middlings. (2) was usually thrown away, (3) was dried and passed over Wetherill machines. In this operation, the magnetic zinc-iron sulfide was separated and sold to a spelter plant. The non-magnetic portion was passed over the "Blake" electrostatic machines. Here, two products were made, the non-conducting zinc product and the iron-product, containing a little lead. This was sold to a lead smelter for a flux. Although the recovery of the zinc was not high, yet the process attained a degree of commercial success.

Lately, the future of the zinc business in the "West" has been brightened greatly, to my mind, by the advent of the Wilfley "roaster." This is the result of ten years' experimenting by that most brilliant yet practical inventor, Mr. W. R. Wilfley.

The first work was done at his "Pride of the West" mine, Washington, Arizona.

It is easy in a hard glass tube to heat iron-pyrites to a low heat and make it magnetic. It is hard to do this on a large scale efficiently and cheaply, because the operation is very delicate. The Wilfley roaster is a high fire-brick shaft with an auxiliary fire-box. The gases from the fire-box flow *down* with the shower of ore. The iron "sulfides" are changed instanter to a magnetic product, consisting of a shell of magnetic oxy-sulfide round each kernel of unroasted material. The ore strikes a water-cooled

shaking hopper, and at once further action is stopped. If the hot gases come upward, the ore would be over-roasted. The Wilfley roaster puts through an enormous tonnage at a low cost. Also, its capital cost per ton of ore is small.

The Wisconsin field has developed a similar operation in a revolving cylindrical roaster. Mr. John E. Dwight also attained similar results at Warren, N. H., some five years ago.

The machine used to separate the magnetic iron material is preferably a low intensity machine, like the "Cleveland-Knowles" or the "Dings." For a detailed description of these the reader is referred to Ingall's above-mentioned report, pages 102-107.

This operation is going to have a great use throughout the zinc mines of the world.

The next important relative advance step in the art of zinc metallurgy is the so-called "flotation" process. The physical chemistry of the operation is but little understood. The practical facts are that when zinc material containing blende is stirred in a hot chemical solution, bubbles are formed. These attach themselves to the zinc blende and rise to the surface, forming a scum which is often a thick curd. This is floated off, the solution allowed to cool and the particles of blende fall down in the cooled solution, in the way grounds of coffee drop when coffee is cooled.

The process seems to have first been invented by Elmore, who mixes crude oil with his ore previous to treatment. Elmore also uses a vacuum to lift the particles of ore.

Some six years or so ago, the "flotation" process was developed more or less independently of Elmore's idea by Messrs. Potter, Deprat and Carmichael severally and conjointly. It would seem from what I can learn that Potter was the real inventor of the practical "flotation," though of course the germ-idea of "flotation" is contained in the original Elmore oil-acid vacuum patent.

It is proven definitely that the gas is carbon dioxide derived from the carbonates in the ore.

Mr. de Bavay even charges the ore with carbon dioxide which can be derived from the gases of combustion of coal, *e. g.*, from the chimney of the boiler plant.

Most of the particular work on the "flotation" process has been done at the Broken Hill mines in Australia.

Mr. W. M. Sanders, when working for me in the laboratory for

metallurgical research of the Lanyon Zinc Company, built at the direction of Mr. F. E. Drake, found that an alkaline aluminum sulfate bath was an efficient "floating" solution. He is now building several plants in the Southern Illinois-Kentucky field to separate blende from fluor-spar. It is impossible to treat in the retort ores containing over 1.5% or 2% fluor-spar, as fluor-spar attacks with avidity the fire-clay of the retorts. And as the two minerals have specific gravities nearly the same, they follow each other closely in water-concentration.

Sanders makes a high-grade product at a high saving, and his work from a metallurgical standpoint is ahead of any figures that I have received relative to the other processes. He also effects a separation of minerals other than fluor-spar from blende.

Mr. H. S. Clark and Mr. Hayman Claudet have been energetically pushing the Elmore oil-acid-vacuum process in this country.

I look for these "flotation" processes to have great influence on the art of treating "complex" sulfides. Their great attraction to me is the fact that they have a great capacity in tons per day for capital outlay. This is the desideratum in any new process.

IMPROVEMENT IN WATER-CONCENTRATION.

This, in a way, should have been treated first. But the more radical new electrical methods have been the stimulation to this improvement, and so came first in the more logical way.

Simplest of all is "sorting" of the ore in the mine and on the picking belt. With the personal equation working at its highest efficiency, "sorting" is a neat and effective way of increasing the saving and the tonnage of a plant. But with slack superintendence, a poor psychology infecting the force, it is most wasteful.

Next, comes careful graduated crushing, reducing the ores by steps so that the constituent minerals are separated from each other without the production of a large percentage of "slimes."

Thirdly, I would place improvement in screening. There have been invented in the past five years several new screens working wet or dry, which, when installed in a thoroughly workmanlike manner, do efficient work. These also reduce the percentage of slimes and make a sized product for the concentration plant.

Fourthly, it is found that such simple expedients as, for example, larger pulleys and shafts for the shaking tables, solid concrete foundations for the same, as well as an even feed of ore and water, increases marvellously the efficiency of the old-fashioned mill of Joplin and the West.

All these several factors change the balance between success and failure. Often they do away with the necessity of the newer forms of concentration except in ores very "crypto-crystallic" in their nature.

There are several more possibilities in the ore-dressing of complex sulfides, such as the McQuestin "tubes," direct concentration, and the "dry-jig," but these, to my mind, have not had the direct practical bearing on the problem that some of the others have had.

Improvement has been made in so many different ways that to-day there are few zinc mines whose ores cannot be treated at a profit, provided that a rational use of known and tried methods and providing the mine is not too far distant from the smelting centers, and the ore is not too low-grade.

All these improvements in ore-dressing would have had little or no effect in the United States outside of the "Joplin" field, and possibly the "Wisconsin" field, had not the spelter plants unbent from their rigid attitudes towards zinc concentrates higher that 1% in iron.

IMPROVEMENTS IN THE REDUCTION PLANTS.

Let it be stated that American practice of reducing zinc ores is radically different from the European practice, for the three following reasons:

(1) Labor in America is dear.

(2) Coal in America is cheap.

(3) Joplin concentrates were abundant from 1880 to 1900, and averaged over 68% zinc roasted.

In Europe labor is cheap, and the calling of the zinc smelterman has been followed for two or three generations in the same family. The ores on which the European smelter plants have depended for supplies, do not average much over 48% zinc roasted.

In America, we use a charge that gives a residue, intended to be

without slag. In Europe, the residues are often sticky, because it is economical with their conditions to scrape them out.

In America, they are usually "blown out" by the auto-generated steam from a pipe, through the perforated end of which jets water.

It would take up too much space to expatiate on all the practical and commercial facts that have resulted in America from these differences. The reader is referred to my paper read before the American Institute of Mining Engineers of Toronto, July, 1907, for a more detailed description.

In treating iron-bearing ores from Leadville, Col., and elsewhere, American practice has simply been a continuation of the practice on Joplin ores and the use of extreme care to make a "dry" or non-corrosive charge. In the first place the charge is "cut" or reduced about 8% to 10%. Next a higher grade fuel is used and a larger percentage of this because the pounds of ore per cubic foot of retort space has been lessened.

We thus have "the pounds of fixed carbon per cubic foot or retort-space" increased and "the pounds of fusible matter per cubic foot of retort-space" decreased. Due to the increase in the ratio or reducing material to "ore," the reductivity of the charge is greatly increased.

Consequently, the zinc is reduced at a lower temperature. Measurements I have made show a temperature some 200° C. less than in Joplin ore.

In addition, exceeding care must be used to reduce the sulfur in the roasting operation to a minimum in ferruginous ore. For, it is pretty well known that iron-sulfide is the corroder of retorts.

Some of my own experience illustrates this. Having seen the necessity in the reducing agent for high fixed carbon and a maximum of carbon activity, I had long been trying to get a material with those two properties as well as very little ash. I tried charcoal and ran a furnace of 330 retorts on a "mix" with varying proportions of charcoal. But charcoal is too bulky and expensive.

Finally, we hit on "oil-coke," analyzing 1% ash, 3% or 4% volatile matter and 94% or 96% fixed carbon. This we found contained heavy hydrocarbons which distilled and condensed in the condenser. Thereby the condenser was choked up.

I therefore rigged up one of our bee-hive coke ovens with a large fan-tail burner and connected this to one of our natural gas

mains. I used this gas so artificially introduced to finish the coking action, just as if it were coal, and in coke furnished its own gas by distillation. We thus made a material practically pure carbon. The cost was not excessive and it would have been possible to increase the furnace charge in ore so much as to be very profitable because of increased metal tonnage we could make with the cheap fuel.

Having worked up five or six tons of this oil-coke to this form, (we slangily called it "boiled coke"), I gave instructions to have it crushed in one of the ore mills, and said particularly that the elevator boots and all must be well cleaned out. I then went to one of the other plants of the company six miles away. On my return, I had three small charges mixed up with 5%, 10% and 15% respectively increased ore charge, to test out our new and ideal reducer.

The "flame" was strong and our residues low in zinc, less than 3%. But the charge "stuck" to the retort most peculiarly. We were puzzled but still kept on. The third charge left the retorts leaking iron sulfide, or rather the iron oxy-sulfide silicate, which results from iron sulfide reacting on fire-clay, through every microscopical crack which it had found out.

The mystery was still unsolved, until I thought of the fact that recently a tonnage of very pyritic ore had been crushed in the same crushing plant that we had used for our "boiled-coke." I then had a sample taken of the coke and found that it analyzed some 7% sulfur. The raw pyrites had done the business and ruined the retorts in three days. This shows exactly what iron sulfide will do in the retort.

One of the great reasons for improvement in the treatment of the so-called low-grade zinc ores from the "West" was due to more careful roasting in the Cappeau-Ropp and Zellweger machine roasters.

Improvement in the mix, so as to give a non-corrosive residue and a charge that would "give up" its zinc at a temperature less than 1175°C. was, as we have shown, another cause.

Great care in the manipulation of the flame outside the retort in the zinc furnace was a third.

Gradually, the zinc smelters of the West are improving the practice, though I doubt if any of them are surpassing much the record of the No. 2 works of the Lanyon Zinc Co. when I was met-

allurgist of that concern, some three years ago. Then we ran with an average charge per furnace for the entire plant of 11900 lbs. of roasted ore, analyzing less than 44% Zu and 19% Fe on a furnace loss of about 19% for the entire month with poor coal and other adverse conditions.

In conclusion let me state that I have not mentioned any of the so-called "wet" zinc processes, because they have achieved no practical and commercial results, nor with the tremendous capital cost needed are they, in my opinion, to achieve any. Parenthetically let it be said that quantitative analytical methods writ large do not spell metallurgy. Nor do reactions suited for a gram of stuff, work well on hundreds of tons.

Nor have I spoken of the Lungwitz "pressure-furnace;" for in spite of great outlay in development, it has had no success on a large scale. I have not given any attention to the electric furnace on which I have been working for nearly five years, for that though promising has not yet been proven for anything commercially but refining dross, etc., and making a high-priced metal.

Undoubtedly, we will see in the next ten years a revolution either in a moderate way by the use of larger inclined gas-fired continuous retorts or in the direct electric furnace. But of one thing I am certain, and that is that the only way to effect any improvement in metallurgy of zinc or any other metal is by a most accurate metallurgical study of the reactions on a small scale with the pyrometer and a most skilful and illuminating forecast of the commercial working of these reactions on a large scale, with regards to labor-saving, metallurgical geography and metallurgical economics; of combining the known with the unknown in a most common-sense way.

That there is an abundant chance for this in the treatment of zinc ores, is seen by the fact that the leading smelters of the country waste annually about as much zinc as is consumed as spelter in the mechanic arts in the United States.

The fact that there are at least six powerful companies in the zinc business will engender a strong competition, for where there is a large field and no favorites, the prize goes to the swiftest and strongest.

Book Notices.

PUBLICATIONS RECEIVED.

United States Commissioner of Education. Report for the year ending June 30, 1906. Volume I, 643 pages, 8vo. Washington, Government Printing Office, 1907.

Michigan State Board of Health. Thirty-fourth annual report of the Secretary for the fiscal year ending June 30, 1906. 176 pages, 8vo. Lansing, State Printer, 1907.

Syracuse Chamber of Commerce. Report upon Smoke Abatement. An impartial investigation of the ways and means of abating smoke; results attained in other cities; merits of patented devices, together with practical suggestions to the Department of Smoke Abatement; the steam plant owner and the private citizen. 42 pages, 8vo.

Canadian Mining Journal, publisher. The Ontario meeting of American Institute of Mining Engineers and their tour through the districts of Cobalt, Sudbury and Moose Mountain. 89 pages, illustrations, portraits, plates, maps; 8vo. Toronto, Canadian Mining Journal, n. d.

Rijckevorsel, Dr. van. Konstant auftretende Secundäre Maxima und Minima in dem jährlichen verlauf der meteoroligschen Erscheinungen. Four parts; illustrations, tables, quarto. Rotterdam, W. J. Van Hengel, 1905 to 1907.

Earthquakes. Supplementary to a booklet entitled, "From Rime to Reason; or, Great San Francisco Earthquake Rhythmically, Orchestrically and Logically Considered." 14 pages, 8vo. Columbus, Ohio, Clarence Miller Jones, 1907.

Science and Art. 6 pages, 8vo. Columbus, Ohio, Clarence Miller Jones, 1907.

New York Merchants' Association. Pollution of New York Harbor as a menace to health by the dissemination of intestinal disease through the agency of the common house fly. A report by Daniel D. Jackson, S.B., to the Committee on Pollution. 22 pages, illustrations, plates, quarto. New York, Merchants' Association, 1907.

United States Bureau of Steam Engineering. Annual report of the Chief to the Secretary of the Navy for the fiscal year 1907. 56 pages, 8vo. Washington, Government Printing Office, 1907.

Pennsylvania State College Agricultural Experiment Station. Bulletin No. 84. Feed as a Source of Energy. 16 pages, 8vo. State College, 1907.

U. S. Department of Agriculture, Forest Service, Gifford Pinchot, Forester. The use of national forests. 42 pages, illustrations, 12mo. Washington, Government Printing Office, 1907.

Pennsylvania State College Bulletin, Vol I, No. 8, October, 1907. Winter Courses in Agriculture at the Pennsylvania State College. 16 pages, illustrations, 8vo. State College, 1907.

On the Concentric Method of Teaching Electrical Engineering by V. Karapetoff. 16 pages, illustrations, 8vo. New York, American Institute of Electrical Engineers, 1907.

The Human Side of the Engineering Profession, by V. Karapetoff. Abstract of an address, delivered before the New York Electrical Society, Edison Auditorium, October 31st, 1906. 6 pages, 8vo. Ithaca, N. Y., 1906.

U. S. Department of Agriculture, Forest Service, Circular 115. Second progress report on the Strength of Structural Timber, by W. Kendrick Hatt. 39 pages, 8vo. Washington, Government Printer, 1907.

Pennsylvania State Highway Department. Report for the year 1906. 21 pages, illustrations, 8vo. Harrisburg, State Printer, 1907.

Zoological Bulletin of the Division of Zoology of the Pennsylvania Department of Agriculture. Subject: The San Jose Scale. Vol. 5, No. 6. October, 1907. 30 pages, illustrations, 8vo. Harrisburg, State Printer, 1907.

United States Geological Survey. Mineral Products of the United States, Calendar Year 1897 to 1906. Sheet 24 x 32 inches. Washington, Government Printing Office, 1907.

U. S. Department of Agriculture, Forest Service. Circular 114. Wood Distillation, by W. C. Geer. 8 pages, 8vo. Washington, Government Printing Office, 1907. Circular 116. The Waning Hardwood Supply and the Appalachian Forests, by William L. Hall. 16 pages, 8vo. Washington, Government Printing Office, 1907. Circular 122. The Lumber Cut of the United States, 1906. 42 pages, table, 8vo. Washington, Government Printing Office, 1907.

Königliches Materialprüfungsamt der Technischen Hochschule Berlin. Bericht über die Tätigkeit des Amtes im Betriebsjahre, 1906. 75 pages, quarto. Sonderabdruck aus den Mitteilungen aus dem Königlichen Materialprüfungsamt Gross-Lichterfelde West, 1907.

U. S. Department of Agriculture, Forest Service, Circular 134. The Estimation of Moisture in Creosote Wood, by Arthur L. Dean. 7 pages, illustrations, 8vo. Washington, Government Printing Office, 1908.

U. S. Department of Agriculture, Forest Service. Circular 132. The Seasoning and Preservative Treatment of Hemlock and Tamarock Crossties, by W. F. Sherfesee. 31 pages, illustrations, 8vo. Washington, Government Printing Office, 1908.

U. S. Department of Agriculture, Forest Service. Circular 133. Production of Veneer in 1906. 6 pages, 8vo. Washington, Government Printing Office, 1908.

Ontario Bureau of Mines. Sixteenth annual report, 1907 (Vol. 16, Part I.) 248 pages, illustrations, maps, 8vo. Toronto, King's Printer, 1907.

Souvenirs Entomologiques par J. H. Fabre. Dixieme Serie. Etudes sur l'Instinct et les Mœurs des Insectes. 353 pages, illustrations, 8vo. Paris, Ch. Delagrave, n. d. Price, in paper, 3 francs, 50c.

In the present volume the author continues his interesting studies on the instincts and habits of insects. He has collected much material on the subject and is able to place it before the reader in an entertaining way.

A. R.

Die Elektrochemische und Elektrometallurgische Industrie Grossbritanniens von John B. C. Kershaw. Ins Deutsche übertragen von Dr. Max Huth. 180 pages, illustrations, plates, tables, 8vo. Halle a. S., Wilhelm Knapp, 1907. Price, paper, 9 marks.

This work is issued as vol. 28 of the series "Monographien über angewandte Elektrochemie." It is a review of the rise and development of the electrochemical and electrometallurgical industries in Great Britain. A supplement contains the full text of eleven English patents covering all the branches of the industries excepting aluminum and calcium carbid. Being basic patents they are of special interest for the purpose of indicating the progress which has been made in the development of these branches of manufactures.

A. R.

Illustrated Technical Dictionary in six languages: English, German, French, Russian, Italian, Spanish, compiled after a novel method by K. Deinhardt and A. Schlomann, Engineers. Volume 1, The Elements of Machinery, and the tools most frequently used in metal and wood working, by P. Stülpnagel. 403 pages, illustrations, 12mo. New York, McGraw Publishing Co., 1906. Price, in cloth, $2.00.

The authors announce a dictionary of technical words, to be complete in eleven volumes. It is intended that each volume shall cover some one department of science or industry. Volumes on hydraulic machinery, hoisting machinery, metallurgy, architecture and naval construction are in preparation. The first volume covers the elements of machinery and tools, and contains an appendix on engineering drawing and mechanics. There is a general index in five languages and a supplement containing the Russian terms. Simple drawings with references from the text make the work more comprehensive.

R.

Bau einer modernen Lokomotive. Zweite, erweiterte Ansgabe mit 42 in den Text gedruckten Netzätzungen von Ingenieur Dr. Robert Grimshaw. 71 pages, illustrations, 8vo. Hannover, Published by the author, 1907.

This pamphlet describes in detail the construction of locomotives as carried on at the plant of the Baldwin Locomotive Works in Philadelphia. There are forty-two half-tones, which include views of the various shops and illustrations of the many types of locomotives and their parts.

A. R.

Sections.

MECHANICAL AND ENGINEERING SECTION.—Stated meeting held Thursday, December 19, 8 P.M. Mr. Chas. Day in the chair.

Present, eighty-six members and visitors.

The Chairman introduced Mr. Axel Welin, of London, England, who presented an address on "Life-Saving Appliances on Shipboard," fully illustrated with the aid of lantern pictures.

Mr. Welin's remarks related especially to the various means and appliances in use on shipboard for the handling of lifeboats, in the course of which he described some improvements of his own invention.

The subject was referred for investigation to the Committee on Science and the Arts. Adjourned.

FRANCIS HEAD, *Sec'y.*

MINING AND METALLURGICAL SECTION.—Stated meeting held Thursday, January 2, 1908, 8 P.M. President G. H. Clamer in the chair.

Present, sixty-three members and visitors.

The paper of the evening was read by Mr. Robt. W. Lesley on the subject of "Cements: their Use and Abuse," and was fully illustrated by lantern views. The paper was fully discussed and was referred for publication.

The speaker was voted the thanks of the meeting. Adjourned.

WM. H. WAHL, *Sec'y pro tem.*

SECTION OF PHYSICS AND CHEMISTRY.—Stated meeting held Thursday, January 9th, 8 P.M. Dr. Robt. H. Bradbury in the chair.

Present, 118 members and visitors.

The paper of the evening was read by Mr. Chas. O. Bond, of the United Gas Improvement Co., of Philadelphia, on "Working Standards of Light, and their Use in Photometry." Mr. Bond's paper was a historical review of the subject of photometry, bringing it down to the present day. He illustrated his remarks by the exhibition of a variety of apparatus, and with lantern pictures. The paper was discussed by Dr. E. Goldsmith, Mr. Waldemar Lee, Mr. Walton Clark and the speaker. The paper was referred for publication, and the thanks of the meeting were voted to the speaker.

Adjourned.

WM. H. WAHL, *Sec'y pro tem.*

SECTION OF PHOTOGRAPHY AND MICROSCOPY.—Stated meeting held Thursday, January 30th, 8 o'clock P.M. Mr. Louis E. Levy in the chair.

Present, 109 members and visitors.

Mr. Morris Earle, of the firm of Williams, Brown & Earle, of Philadelphia exhibited and described the properties and advantages of a new Isostigmar Lens devised by Messrs. R. & J. Beck, of London.

Mr. J. E. Brulatour followed with a paper on a new method of color photography, now being exploited by the Lumiere North American Co., Ltd., of New York.

Mr. Brulatour illustrated his remarks by the exhibition of a number of lantern photographs showing the progress that has been made in the development of the Lumiere process.

Both communications were freely discussed.

On Dr. Griggs's motion both inventions were referred for investigation and report to the Committee on Science and the Arts.

M. I. WILBERT, *Sec'y.*

SECTION OF PHYSICS AND CHEMISTRY.—Thursday, February 6th, a stated meeting of the Section was held at 8 o'clock. Dr. Robert H. Bradbury in the chair.

Present, thirty-two members

The paper of the evening was read by Dr. Edward A. Partridge, on the subject of "The Electron Theory."

The paper was discussed by Dr. Edward Goldsmith, Dr. Bradbury, and the speaker of the evening.

Dr. Partridge was voted the thanks of the meeting and the session was adjourned.

WM. H. WAHL, *Sec'y pro tem.*

MINING AND METALLURGICAL SECTION.— A regular meeting of the Section was held on Thursday evening, February 13th, at 8 o'clock.

Present, thirty-four members.

Mr. G. H. Clamer in the chair.

The paper of the evening was read by Mr. Chas. L. Huston, President of the Lukens Iron and Steel Company, Coatesville, Pa.

The subject was, "Practical Experiments in Steel," and was fully illustrated. The paper was freely discussed.

The thanks of the meeting were voted to the speaker of the evening, and his paper was referred to the Committee on Publication. Adjourned.

WM. H. WAHL, *Sec'y pro tem.*

The Franklin Institute.

HALL OF THE INSTITUTE,
PHILADELPHIA, February 19, 1908.

DR. EDWARD GOLDSMITH in the chair.

Present, fourteen members and visitors.

The Chairman introduced Dr. Chas. D. Thruing, of Philadelphia, who presented a paper on A New Radiation Pyrometer. The speaker illustrated his remarks by means of diagrams and apparatus.

The subject was referred, on motion, to the Committee on Science and the Arts for investigation and report. Adjourned.

WM. H. WAHL, *Secretary.*

On Friday evening, February 14, a reception was tendered to the members and friends of the Institute by the Board of Managers and officers.

The entire building was thrown open to the visitors. The Library and Reading Room were handsomely decorated, and made specially interesting by the display of numerous models of machines, many of them having historic value, and by a fine and varied collection of photographs.

In the offices demonstrations were given with X-ray and other interesting physical apparatus.

Dr. Persifor Frazer addressed a large audience in the Lecture Room with a lecture on "The Franklin Institute: its Services and Deserts." The lecturer illustrated his address—which was an exhaustive historical sketch of the Institute, by the exhibition of a large number of lantern photographs, principally of those who have distinguished themselves in the service of the Institute.

A large number of members and friends were present, who thoroughly enjoyed the occasion.

The following is a list of models, photographs, etc., which were specially sent for exhibition:

EXHIBITORS' RECEPTION, FEBRUARY 14, 1908.

The Electrelle Co., Interior piano player.

The Victor Talking Machine Co., The Auxetophone.

Mr. S. Lubin, Motion pictures.

Roentgen Mfg. Co., X-ray apparatus.

Williams, Brown & Earle, X-ray apparatus.

The Philadelphia Electric Co., General lighting: tantalum and tungsten lamps; luminous radiators, electric fountain.

The Philadelphia Gas Works, Exhibit of photometric standards.

The Baldwin Locomotive Works, Model of "Old Ironsides," working model of Vauclain balanced compound valve motion.

The William Cramp Ship and Engine Building Co., Working model of hull of Clyde Line steamship.

Mr. J. Allen Heany, Heany tungsten lamps.

Goldschmidt Thermit Co., Specimens of Thermit welding.

American Cement Co., Specimens of cement.

K. & B. Co., Richard L. Binder, President, Electrical appliances.

The Welsbach Co., Lighting of hall and stairway by gas (Reflex lights).

The United Gas Improvement Co., Heating hall with Kane generators.

Cooper-Hewitt Electric Co., Two Cooper-Hewitt lights in lecture room.

PICTURES.

Baldwin Locomotive Works, Photographs of locomotives.

Mr. H. F. Colvin, Photographs of early locomotives.

American Cement Co., Illustration of the growth of the American Portland cement industry.

Mr. F. Gutekunst, Photographs of scientists.

Berry-Homer Co., Monster photographic enlargement.

Mr. W. N. Jennings, Photographs of lightning flashes, scenes in London, Paris, and Philadelphia, commercial work.

Dr. Chas. F. Himes, Photographs of historic documents.

Mr. W. J. Hammer, Photographs made with fire-flies and phosphorescence.

GENERAL PHOTOGRAPHIC WORK: VIEWS AND STUDIES.

Richard Gilpin, Dr. W. O. Griggs, Werner Kaufmann, I. P. Pedrick, J. W. Ridpath, W. H. Thorne, U. C. Wanner.

Specimens of work of the students of the Schools of Drawing and Naval Architecture.